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# Emerging Technology Adoption and Use

*Consolidated Assignments from Spring 2020*

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## FOREWORD

Digitalization changes the world. Information systems, software applications and other technologies are in a central role in this change. They enable new work practices and processes, new business models and opportunities, initiate changes in how technologies are used, perceived and interpreted, and ultimately force individuals, organizations, and even societies at large to respond to those changes. Individuals, organizations, and societies have to somehow transform and adjust their old ways of doing things.

Yet, not only technologies drive digital transformation. Increasing amounts of data that is produced by numerous sensors, applications, and systems account for the transformation as well. Such data is gathered and collected, merged together, and analyzed by different methods and tools; by using artificial intelligence, data analytics, or data science. The sense-making of such versatile data is of importance because not only can it be used to improve decision-making at workplaces but also, it can be utilized for the benefit of individuals and societies, in organizational and non-work settings.

These views, transformation and smartness, pose several questions for information system (IS) research. In general, we might ask what actually is the smartness of individuals, organizations, or a society. We can even ask whether stakeholders possess the required abilities, skills and competences to enable and support the change. These, and other related questions arise due to fast evolving landscape of information technology, and information and technology. The nuanced understanding of Smart Transformation in IS has become even more critical due to governmental and organizational programs that foster smartness.

This report summarizes research reports of students attending “Emerging Technology Adoption and Use” course in Tampere University. During the course, we focused on three emerging technologies.

Extended Reality

Blockchain

Artificial Intelligence

Each group collaborated on finding a common topic of interest. They focused on the adoption and/or use of a particular emerging technology in a setting of their own choosing. As you are about to see, the findings of each group emphasize different perspectives. These range from the negative effects of technology use to the opportunities and delights of information systems.

We hope you take a moment to read about the state of the art research in Information Systems and Information Management. Enjoy.

21.4.2020 Tampere

Teachers –

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# APPLICATIONS OF DEEP LEARNING IN FINANCE

Group Assignment
Emerging Technology Adoption and Use
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# ABSTRACT

Piispanen, N. Sundqvist, R. Vuotila, R. Matilainen, V.: Applications of deep learning in finance
Technology: Deep Learning
Context: Selected fields of finance sector
Lens: To explore and understand

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Deep Learning is becoming usual technology in many fields. In this paper, we discover deep learning methods utilized in finance sector. We also evaluate the maturity of the technology in different areas of finance sector. Deep Learning is not yet the most used technology in finance sector, but our research suggests that some problems in the field does require features of deep learning.

Keywords: Deep Learning, Finance, Machine Learning, Artificial Intelligence

# INTRODUCTION

Deep learning is an important new technology in artificial intelligence and machine learning. It enables using neural networks composed of multiple layers. These layers then learn to recognize different features of the data being analyzed. It has proven to be more powerful than previous machine learning techniques in for example image recognition and speech recognition. It has also produced good results in natural language understanding, topic classification, sentiment analysis and question answering. (LeCun et al. 2015)

In this research we look at the possible implementations of deep learning in the finance sector. The research question we focus on is “How is deep learning used in different use cases in the finance sector?”. The use cases we focused on were fraud detection, risk assessment, trading markets and customer service. Other use cases for deep learning also exist in the finance sector, but in order to limit the scope of this research we chose to focus on the mentioned four.

The research lens we chose for this research is to explore and understand. The research method is a literature review using both academic literature and other online sources. This work is divided into a chapter describing the four use cases followed by a main chapter for each use case and finally a conclusion chapter. Each main chapter describes the usage of deep learning in the specific use case. Then the pros and cons of current solutions are explained and finally there is a brief look at possible future development for deep learning solutions in the specific use case.

# USE CASES OVERVIEW

## Fraud detection

An area where deep learning might have a major impact is to detect frauds in financial transactions (Roy et al. 2018). In this assignment frauds are considered to mean unauthorized use of someone’s credit card. Credit card has been rapidly growing payment method. The transactions can be made physically and online and specially the online transactions provide possibilities for fraudulent actions.

Because of the banking industry, detections of the frauds need to be accurate and there are no room for false positives. This means that cost of flagging legal

actions as frauds is high. These errors will easily get customers to switch their banking services. Deep learning methods are hungry for data to learn patterns and number of daily credit card transactions will provide that. However, the number of fraud actions are minimal compared to the legal actions and the imbalance can lead to flag also legal actions.

Regular machine learning methods have been utilized for detecting frauds for a long time and are still currently the more used way to solve the problem. In this assignment we examine, what are the key features in fraud detection which suggest that deep learning might turn out to be the best technique for the task.

## Risk assesment

One of the key responsibilities of a bank is to lend money to its commercial and corporate clients. Banks play an important role in the economic system receiving deposits and enabling financing to those in need. Due to their role, banks are highly regulated entities which are expected to follow strict regulations and act responsibly in their operations. (Kostadinov 2019a.)

One main earnings method for banks is to receive interest income as a compensation for taking a risk when loaning money. Careful credit risk evaluation is required to minimize the risk of a customer defaulting on their loan and incurring losses for the financier. Customer's credit worthiness can be assessed in several ways, but often similar aspects show up. These can be described as the five C's of credit worthiness. First C stands for character. Here the borrower's reputation is evaluated based on their previous credit history. Second C stand for capacity and the focus is on comparing the borrower's income against their debt expenses and assessing whether their debt-to-income ratio is at a suitable level. Third C stands for capital – how much own money the borrower is ready to invest towards a potential investment. Usually the financier requires the borrower to have a certain percent of own money contributing to the project in order to secure the financing. Fourth C stands for collateral which is an asset that the financier requires the borrower to provide and acts as a back-up if the borrower has problems repaying the debt. Fifth and the final C stands for conditions which is a very general term including the financing details of a loan, such as the interest rate, and

the overall economic situation covering employment rates etc. (Kostadinov 2019a.)

The process of applying financing has greatly changed from the past as customers have plenty of options to apply financing from and speed plays an essential role in all business. The prerequisite of speed and efficiency sets challenges for the traditional way of evaluating creditworthiness. When human efficiency can no longer meet the needs, companies have turned to the help of machine learning algorithms which have been applied in assessing credit risk for already more than a decade. (Kostadinov 2019a.) Developing and applying quantitative credit scoring models in their business has become a major focus of financial institutions. Their main aim is to quickly and accurately separate credit defaulters from creditworthy customers. This interest has led to the intensive research on the performance of different classification algorithms. (Gunnarsson 2018.)

## Trading market

In stock market deep learning could provide implementations to predict changes in share prices and other stock market instruments. This is based on its ability to gather and process data which is superior to other AI solutions (Chong et al. 2017). If done correctly, this would make a tremendous increase to funds' capital gain and therefore have a significant impact on stock market and economy overall. The problem is that even though the technologies exist, both deep learning and active trading done by AI, there has been no perfectly accurate algorithms yet. Although, it is thought to be impossible to create one.

Even though the technological development isn't complete yet many investing actors have established deep learning solutions to support their investing strategy. However, the relying completely on deep learning when making decisions is far-fetched in the current state of the technology. There are a lot of risks and uncertainity around the subject and its effects on economy if perfect algorithms appear and will be established as a major investing strategy.

## Customer service possibilities

Customer service is traditionally very labor-intensive. A single customer service representative can only serve a set number of customers and increasing the amount of customer service representatives has often been the only way to scale up customer service operations. In doing this the costs of customer service scale linearly with the number of customers being served.

For banks and insurance companies the amount of revenue a single customer brings in can for some customers be quite small. Even then the customers might need some amount of customer service. For the account to remain profitable, the cost of customer service for these customers' needs to be very small. This is where automating customer service can help. Automation can on the one hand help customer service representatives serve a larger number of customers, and on the other hand it can make it possible for a company to serve a set number of customers with a smaller amount of customer service operators. Another possibility artificial intelligence solution offer in customer service is improving the customer service experience by helping customer service representatives serve their customers better. This can be done by analyzing the customer service communication, for example phone call or chat, in real time and offering advice on how to improve it.

# USE CASE 1: FRAUD DETECTION

What makes detecting frauds challenging is the dynamic nature of them. (Adewumi & Akinyelu 2017). Cybercriminals come up with more and more sophisticated innovations, which makes them hard to adapt. Also, the proper research datasets do not exist yet (Adewumi & Akinyelu 2017). There might be lot of evolved fraud detection techniques inside companies but due to privacy issues the collaboration with researchers and companies does not exist. Also, reliable benchmarking between different techniques within academic community is lacking. Ryman-Tubb et al. (2018) compares over 50 methods from over 100 papers but admits that the ranking between different technologies is only directive and should not be used for model selection purposes.

Technical overview

During this day, ordinary machine learning models are still the most used technologies to use in fraud detection. In 2018, rule-based systems and decision tree algorithms were the most established AI techniques used in fraud detection (Ryman-Tubb et al 2018). In 2017, a study found that a deep learning approach provided comparable results to prevailing fraud detection methods such as tree algorithms and logistic regressions (Roy et al. 2018).

Fraud detection is a classification problem, where transactions are being classified into legitimate and fraudulent transactions (Adewumi & Akinyelu 2017). However, recently some unsupervised techniques have occurred. Mubalaike & Adali (2018) does introduce stacked auto encoder (SAE) and restricted Boltzmann machines (RBM). In both methods, patterns in the data are discovered in a manner of detecting anomalies and then decoding the features back to the original form. The anomalies are detected if the decoding of the features does not match to the original data. Unsupervised methods do work well in rapidly evolving task such as fraud detection since the training data can be outdated to recognize new types of fraud patterns (Mubalaike & Adali 2018). Deep learning methods can be utilized to these prediction models by stacking layers on each other. However, SAE does not beat the accuracy of traditional machine learning prediction models, but RBM slightly exceeds them. (Mubalaike & Adali 2018)

Problem is also black box nature of the algorithms (Ryman-Tubb et al 2018). This means that the classification algorithm does not explain the reasoning behind the logic. Because of the complexity of the explored data, human is not able to perceive the logic of some transaction being a fraud. Understanding the reasoning detecting frauds would enable more accurate field of investigations in the future.

Using Deep Learning models does require much more computing power than ordinary machine learning models. In their research, Abhimanyu et al. (2018) used an environment of 16 GPUs, 64 CPUs and 732GB of RAM. GPU, Graphical Processing Unit, was found out to be optimized well to handle calculations needed in machine learning and many companies do provide especially them for third parties to use. In their research, Abhimanyu et al. (2018) implemented a recurrent neural network, which in addition to regular artificial neural network, adds a memory unit to the network. Normally these recurrent neural networks manage well in tasks such as speech or text recognition where the history input

dictates classification probabilities for later inputs. According to Ryman-Tubb et al. (2018), networks with memory units outperformed significantly normal artificial neural networks. This indicates that the chain of events is a key successor for detecting fraudulent patterns from transaction data. For example, the chain of events could include attempts to change PIN-codes and many similar types of transactions sequentially. Other technologies which implement the memory unit are Long Short-Term Memory (LSTM) and Gated recurrent unit. Specially the LSTM is proposed in many papers to be used in fraud detection problems.

## Pros and cons

Deep learning models does beat regular machine learning models when there are lot of complex data available. (Adewumi & Akinyelu 2017). Deep learning methods can handle the sequential data better than traditional models, which seems promising approach to handle fraud detection. Using sequential models such as recurrent neural network requires lot of computing power itself but at the same time the number of transactions made with credit cards suggests using as light models as possible. Computing power is available in cloud and many companies provide GPU for customers to use.

One hot topic of AI is interpretable learning. The machine learning models have turned out to evolve to so-called black boxes and you could not perceive the hidden logic of what identifies the transaction as a fraud. When classifying actual human beings, the transparency for the model could be essential. On the other hand, as said earlier, the number of the daily transactions are enormous, and the manual detection of the frauds are impossible. When the detection process is automated, and no person is making decisions on transactions, the transparency might not bring that much of a value.

## Future development

For the reasons pointed out, we strongly believe that deep learning will have a permanent foothold in the industry. The usage of the deep learning models is usually more practical than theoretical and the best classification results will be clarified with trial and error.

The one key problem has been siled development of the machine learning models. New directives such as EU-GDPR take personal data in the centrum, and therefore it might lead to larger anonymisation of the data. This way, the cross-organizational cooperation might leverage.

Interpretable models of machine learning have been discussed increasingly. When individuals are being classified, transparency of the model is often required. We believe that interpretable models will be hot topic in the banking industry and the models in the future will have more transparency to the classification logic.

## USE CASE 2: RISK ASSESSMENT

Machine learning can be beneficial for credit business by making use of new data sources for predicting credit defaults. Humans generate huge amounts of data mainly thanks to social media. Algorithms can credit score customers based on underlying patterns in thousands of data points from different data sources. (Kostadinov 2019b.) Developing tools to ease credit assessment is not a new trend at all. Banking industry has developed different models ever since mid-1950's and these have been perfected with huge amounts of money. Traditional credit risk models utilize machine learning methods, such as logistic regression, and rely heavily on loan application questionnaire and the applicant's previous credit history. This can prove to be a problem if the customer doesn't have a significant credit history to get enough data from. Traditional, non-machine learning models also don't take full advantage of all the available data of the customer. (Babaev et al. 2019.) More sophisticated algorithms that take on more parameters provide a solution to tackle this problem. Technology has advanced so well that most lending institutions are renewing their business models to better utilize Big Data and computing power in order to make predictions and monitor performance. (Addo et al. 2018.) Deep learning is one solution to assess complex data from multiple sources.

## Technical overview

Creating a neural network to assess credit risk starts with data collection and processing. For the model to function properly, it is important to have lots of data that describe real life environment as accurately as possible. Problems can occur if the sample data is imbalanced. In the case of credit risk assessment, a sample data from a time period that has a non-normal rate of defaults will likely cause problems when predicting the future with the created model. (Chen & Yang 2018.) In a study conducted by Petropoulos et al. (2018), the researchers gathered data from a 10-year period with semi-annual information to approximate a full economic cycle in terms of varying default rates. Chen & Yang constructed a deep learning model for assessing credit risk and predicting default rates by using sample data from 1990 to 2014. They also emphasized the importance of using more accurate time series data by discretizing sample credit data to quarters instead of using just yearly numbers. When developing a model, the data is divided to different parts with one group acting as a train data set and another group used for testing. Chen & Yang divided their training data to two parts, 80% testing and 20% validation. Their model training included dividing the data into two training sets one set using data from 2002 to 2007 to predict default rates in 2009 and the other utilizing data between 2003 and 2008 to predict default in 2010.

Choosing predictor variables is the next phase when doing data modelling. It's no easy task to fit a machine learning model to a great number of independent variables due to dimensionality problems so choosing the right and necessary ones becomes important. Petropoulos et al. (2018) chose their predictor variables using an algorithm that independently chose the variables which it considered to be most relevant in terms of importance. In their study 65 out of initial 354 variable candidates were selected to the final model. The inputs used by  in their algorithm included various intrinsic features of loans, such as loan terms and charge-off dates, and different indicators for macroeconomic situation, like S&P 500 index and unemployment rates.

Deep neural networks with multiple hidden layers are constructed using linear activation functions, generally used being logistic sigmoid and rectified linear unit. Deep neural networks can easily be overfitted due to the vast number of trainable parameters. That's why it is essential that some techniques are employed to prevent them from overfitting. The most popular technique to regularize deep neural networks has been dropout where different network units are randomly dropped out on each training algorithm iteration while still ensuring that all network parameters are effectively trained. (Petropoulos et al. 2018.)

Generally used measurements for quantitative classification accuracy and discriminatory power of a model are Area Under the ROC curve (AUC) and Kolmogorov Smirnov statistic (Petropoulos et al. 2018). The ROC curve shows the ratio of true positive and false positive rates. When forecasting the future, an AUC rate of 0.8 is considered good. (Chen & Yang 2018.) In their study, Petropoulos et al. noted that the most important financial ratio predictors for the default probability of a company is ROE followed by the availability of working capital and interest expense coverage.

## Pros and cons

Despite the possibilities that arise due to the usage of deep learning, academic field is still polarized when it comes to choosing the best algorithm for credit assessment. Machine learning applications are seen to be so far the best tools to assist analysts in credit scoring or even handle them independently but there is little consensus about the best application. Machine learning models that frequently appear in the academic literature are logistic regression, random forest, gradient boosting and neural networks including deep learning. Random forest and gradient boosting are so called tree-based models which means that they utilize decision trees with the sample data. Gradient boosting builds trees one at a time where the next tree helps to correct the errors made by the previous one and thus leading to a better accuracy. This method combines the result along the process. Random forest takes a random set of the data and trains each decision tree independently. The results are combined only at the end of the process. (Glen 2019.)

According to our research, tree-based algorithms are most often considered to reach the best results in academic articles evaluating different algorithms in their ability to predict credit risk. Kostadinov (2019a) notes that in one research gradient boosting outperformed all models including deep learning-based ones. Gunnarsson (2018) found out that random forests were the overall best performing classifiers over all data sets and indicators of performance. Addo et al. (2018) add that their findings indicate that tree-based models are still more stable than multilayer neural networks and that using deep learning doesn't necessary provide enterprises with very interesting results. Gunnarsson (2018) continues that deep learning solutions often require much greater computational costs than other machine learning applications and that they would be most useful when handling high-dimensional data. However, this is often not the case in credit risk modelling which may be one reason why deep learning doesn't provide considerable improvements to this field. All the researchers above suggest that tree-based algorithms should still be used when assessing credit risk.

Deep learning is being developed and researched at a fast pace. This may lead to these algorithms being more powerful and of better use to the credit lending industry than the previous solutions. One important factor that should be taken into account is the constantly tightening regulation around the finance industry. Neural networks operate in a manner that is difficult to understand and are therefore sometimes called black-box models. This leads to issues with the lack of interpretability. (Babaev et al. 2019.) Financial institutions are expected to act responsibly and be able to back up their decisions which can prove to be difficult in the era of credit assessment done by neural networks. Addo et al. (2018) add that there is still a need for human supervising the final decisions as it's important that new data science techniques don't discriminate people based on wrong use of algorithms. New solutions must also be compliant with data privacy regulations such as GDPR.

Nevertheless, there are also opinions supporting deep learning. Kostadinov (2019a) believes that it's just a matter of time when deep learning models will overcome other machine learning techniques. He refers to a study conducted in Brazil in 2018 where 5-layer deep neural network outperformed existing solutions when assigned to detect risky customers on complex and unstructured credit card data. Babaev et al. (2019) were able to develop a deep learning credit risk model which worked well with complex multivariate time-series data. They also emphasize deep learning's ability to learn meaningful representations of the input data during the training period which dramatically reduces the need to manually create aggregate features which is usually done in credit scoring applications. In addition, their model was able to make decisions in nearly real-time due to the process being fully automated.

## Future development

McKinsey & Co., a respected management consulting company, claims that by 2025 risk management functions at financial institutions would be totally different from what they are nowadays because of strict regulations, evolving customer expectations and changing risk types. Emerging technologies and advanced analytics lead to new services and risk management techniques to be available. Machine learning is highlighted as a technology with potentially critical implications for risk management since its applications can enable the building of accurate risk models by being able to assess complex data sets and identify underlying non-linear patterns. The predictive power of neural networks can grow with more information added from big data therefore leading to enhancing power and accuracy over time. For these characteristics it is expected that the applications of machine learning will be utilized across multiple areas within a bank's risk management functions and it can serve as a transformation leader in this field. (Leo et al. 2019.)

Majority of academic research yet finds tree-based algorithms more accurate than neural networks. Deep learning is still considered to provide promising results based on their opportunity of creating a large combination of different structures based on the number of layers in the net, the selected activation functions

and normalization layers that can be inserted when optimizing the model. For these reasons the potentials of deep neural network algorithms are significant in the era where big data is dominant and recognizing underlying patterns in huge datasets is of great importance. The increasing flexibility of the structures of these solutions can lead them to outperform boosting and forest algorithms. (Petropoulos et al. 2018.) Some are even more confident on this development and believe that as more data becomes available for use and more institutions are capable of running heavy deep neural networks using reasonably priced computing power, deep learning will undoubtedly become the standard way of assessing credit risk. (Kostadinov 2019a.)

## USE CASE 3: TRADING MARKET

There's a big interest towards deep learning in the stock market. In theory it could outperform human investors and current IT-based investment decision making solutions. This is because of the deep learning's ability to process raw data efficiently to predict shifts in stock market. There isn't one certain way to conduct a deep learning network to fit market prediction. Instead, multiple different experiments are with each of their own way process data have been established. (Chong et al. 2017, p. 187)

As deep learning can revolutionize the stock market and economy there's been a lot of research and development to create efficient algorithm. The required technology and software exist but there hasn't been perfect algorithms yet. There's still been successful implementations already and many investing authorities use deep learning to support their stock market decision making. Although the possibilities are tremendous there's still a lot of challenges to overcome and even negative risks. In long term the consequences are very uncertain as the technology may effect the whole global economy.

### Current state & research on the subject

Currently there are multi-layer neural networks that can predict stock market for short term quite accurately. Therefore, they could be used for active traders, like

fund managers, to support their investing strategy. However, for long-term passive investments there are no accurate deep learning algorithms yet. (Chong et al. 2017, p. 203)

There are multiple approaches to the subject on how the algorithms should be established and on what emphasis. Technical analysis states that future behavior of certain stock market instrument is conditioned to its' past. The algorithms for neural network layers may be established with help from math and statistics. Fundamental analysis means that the value of instrument changes by external factors such as politics and economy. This is more difficult because it's very challenging if not impossible to create a deep learning AI that can search and identify relevant news and financial reports, which are unstructured data, and understand the impact of them. The third approach combines those two. The most accurate predictor in stock market would be a deep learning network than can not only process and understand the impact of unstructured external data but also combine that information to the financial past. (Vargas et al. 2017)

According to researches on the subject, neural networks and deep learning are the most efficient techniques of machine learning in the stock market (Iqbal et al. 2013, p. 855). Though, there have been multiple deep-learning variations on how to build the system. They all perform better than a basic single-layer neural network but some of them require a lot of energy, processing power and computing capability to work. Therefore, putting up a deep-learning system to manage funds and investments is itself a great investment.

## Pros & cons

Deep learning technology in stock market has brought many benefits. The transactions in stock market are mostly automated because of innovations like this and less manual work is required to trade. Also, it is owerpowering technology when it comes to raw data processing because open data it collects from the web can contain crucial information regarding stock market. This is the reason it outperforms human investors and other AI based investing tools if done correctly. Deep learning -based funds are also a good option for those who trust statistics, financial history and mathematics and don't want to take much risk or base their investments on human emotions and thoughts.

Cons are the lack of possibility to establish a perfect algorithm than analyzes and understand relevant external data. That sector is possible for human because of the understanding of human emotions, reactions and external data. Another negative side is that if problems occurs with the deep learning system and it fails in the stock market, investors will lose money. The amount of money lost would depend on the impact of the problem and the time frame of when it's detected and how long it takes to repair it.

### Future development

Developing and establishing deep-learning technologies for investing isn't risk-less. There's a risk of losing great deal of money and customers if problems occur with the system and the algorithm has a flaw that makes it do bad decisions in the market. There's also a lot of uncertainty of consequences if there would be a as perfect as algorithm as possible in the future, almost completely unmistaken. If the technology and algorithm would be shared, then every bank and investor would probably adapt it. But then, what would the effects to the global economy be if we had a system that knows the future of exchange price fluctuation? Or if every person who invests directly or indirectly has put their money to that deep-learning system and a technical problem occurs with the system or even total crash?

## USE CASE 4: CUSTOMER SERVICE POSSIBILITIES

In customer service artificial intelligence has two main uses. One is to lower personnel costs by automating customer service. The other is to improve the customer service provided by customer service representatives by analyzing their performance and other data. Customer service solutions are not typically based on a single algorithm that could be interchanged to one using deep learning. Deep learning is not necessarily a prerequisite for building working solutions, but is instead used as one tool that can make customer service solutions perform better.

### Customer service solutions utilising deep learning

One challenge in automating customer service is for the automation system to understand the customer's communication. Natural language processing is a

technology used to process the inputs that people produce in a natural human language into a form that is meaningful to a computer. Recently deep learning has been an important technology in the development of natural language processing (Kalyanathaya 2019).

In customer service operations the use of natural language processing has various uses. One is using natural language processing in building a chatbot interface or virtual assistant (Kalyanathaya 2019). More sophisticated natural language processing solutions enable chatbot interfaces to provide better service to customers compared to simpler solutions. Simpler solutions can have more difficulty interpreting what customers want, and customer service representatives need to take over the chats more often. Another use for natural language processing in customer service for banks and financial institutions is using it in document search applications, enabling customers to make basic transactional queries (Kalyanathaya 2019).

Deep learning can also be used in customer service for its predictive analytics capabilities. One application is predicting call arrival on the level of a single customer. As companies gather large quantities of data on their customers and especially the activities of specific customers, that data can then be used to predict customer behavior. Moazeni (2019) researched using customer data of a large insurance company in the United States to predict customer contacts. According to the research the probability of a specific customer calling within the next 30 days can be predicted with a high level of accuracy based on the customer's online activities. Aggregating this information then provides a good estimate of the total volume of telephone queries (Moazeni 2019). This information can then be used for customer segmentation and planning needed customer service staff levels.

Another application for deep learning in customer service is real time analytics on customer service phone calls to provide suggestions to the customer service representative how to improve the call. In one solution a deep learning-based analytics system analyses the tone and content of a phone conversation in order to evaluate how the customer is feeling and if the phone call is going well. Then the system can offer suggestions to the customer representatives for improving the

call. The system was tested in a large insurance company where it improved both customer satisfaction and issue resolution. (Walker 2019)

## Pros and cons

Deep learning is used in customer service applications as a tool for improving artificial intelligence solutions in use. The pros for this reason are mostly better and more accurate operation of the artificial intelligence tools and more accurate predictions in analytics tools. An important downside on the other hand is the higher amount of data required for deep learning. If a sufficient amount data is not available for a specific application, deep learning might not provide the desired results.

Using artificial intelligence in customer service also introduces ethical questions that need to be thought about. When customer service is automated, some decision making can be made by automated software in situations where previously someone has made the decision. This can have both positive effects where everyone gets fair treatment from the AI solution, and negative effects where people's specific circumstances are not taken into account. Black box solutions where the inner workings of the AI solution are difficult or impossible to describe are especially problematic. Financial decisions can be very important in people's lives, and an AI solution proposing a specific course of action, such as offering a specific product from an insurance company's portfolio instead of another one, can have significant personal consequences.

## Future development

According to Kannan and Bernoff (2019) in the future in customer service artificial intelligence will be used in collaboration with human customer service representatives. AI solutions will handle simpler requests and human intervention is only required when the AI faces something it cannot comprehend or directly solve. The AI solutions will also need to improve based on their previous encounters. Customer service representatives can also flag issues where the AI has not been able to solve the customer's request and the system can then learn from the situation. (Kannan & Bernoff 2019)

Deep learning is an important tool in enabling the future development of AI in customer service. It is one of the tools used in improving the natural language processing that AI systems use to understand the customers' requests. Deep learning can also enable the AI systems to learn from their previous interactions.

## CONCLUSION

In many classification problems the demand of machine learning algorithm is determined by data complexity. Ordinary machine learning models are usually easier to adapt and observe, which makes them better for use-cases where features of the data are well defined. In finance sector, traditional machine learning models are still the most common ones. However, attempts of implementing deep learning methods have started to occur. Credit card fraud detection is proven to be more effective with recurrent algorithms which suggests that deep learning will play a bigger role in the future.

The growing amount of big data sets new challenges for traditional risk assessment. Ability of combining a vast number of data points from complex different data sources will play an important role in credit scoring. Deep neural networks are proven to be good at handling massive data sets with high-dimensional data. However, so far other machine learning solutions, especially tree-based algorithms, are regularly found to be the best way of assessing credit risk but the situation is expected to change due to deep learning being developed and researched at a fast pace. The predictive power of neural networks grows as more and more input data is becoming available and they can be of great use detecting underlying patterns in huge datasets. For these reasons, it's not far-fetched that deep neural networks will become the standard way of assessing credit risk in the future.

In stock market and trading successful deep learning adaptions have occurred and many banks use it as their funds' investment strategy. There's plenty of research and development going on to make even more accurate and long-term algorithms. The current challenge to overcome is the recognition, analyzing and making choices based on external, unstructured data such as news and financial reports. That data has a great impact on stock market. Also, the current algorithm

cannot make very long-term predictions. The most capable systems make decent calculations and predictions only for minutes at maximum.

In customer service applications deep learning is used in the same way in the finance industry as most other industries. Artificial intelligence makes it possible to automate some customer service functions that have previously needed to be done by customer service representatives. Deep learning opens new possibilities in interpreting customer input and analyzing the customer service situations in real time.

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# BLOCKCHAIN – TACKLING THE ACADEMIC CREDENTIAL VERIFICATION PROBLEM

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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## ABSTRACT

Tackling the Academic Credentials Verification Problem
Tampere University
Group Assignment, 11 pages

This report examines the current situation regarding the Academic Credentials Verification Problem, and how a technology such as blockchain could be used in order to confront those problems. We will have a look at several features this blockchain application can bring to the educational system and discuss a bit on several aspects of some of the existing solutions: scalability, transaction costs, and hierarchy schemes.

Keywords: Blockchain, Education, Credentials Verification

## INTRODUCTION

Lying on your resume is more and more common and it is hard for employers to verify the credentials of people they interview. There have been a few cases of CEOs being caught lying about their academic credentials. There are already some solutions that offers a way to tackles this problem. These solutions use the technology of blockchain to offers to their client a secure way to store their credentials. There are still a few question marks about this technology like how it would work on an international scale. As mentioned, this report will focus on the academic credential fraud. The analysis will be done for the education industry on a macro level. The goal is to show how this technology works and what are the current solutions. This report will focus on what is currently on the market and

what the blockchain offers right now to solve this academic credential fraud problem. In the following pages, the report will cover the solutions that the technology offers, how it can work on an international scale, the costs relate to the transaction and finally the hierarchy of the blockchain.

## WHAT THE BLOCKCHAIN OFFER AS A SOLUTION

Using Blockchain as a solution for fighting the academic credential fraud is a good idea. This technology offers many solutions that can be useful in this situation. To be able to prevent fraud, the need for a secure platform is big. But why would people go trhough blockchain for that kind of verification?

Before going through how it would work, let's see what the blockchain solution would offer:

1. Credentials (degree, certificate) validation;
2. Vetting the academic institution;
3. Creating a tamper-proof record;
4. Complete academic histories.

It is about a secure platform where you can't fraud yourself in. It is then easier for the employers to verify the credentials of someone and it assure them of the validity of these degrees. The picture below taken from the website of Edgecoin (one of the blockchain solution offered) shows what are the services this technology can offer.

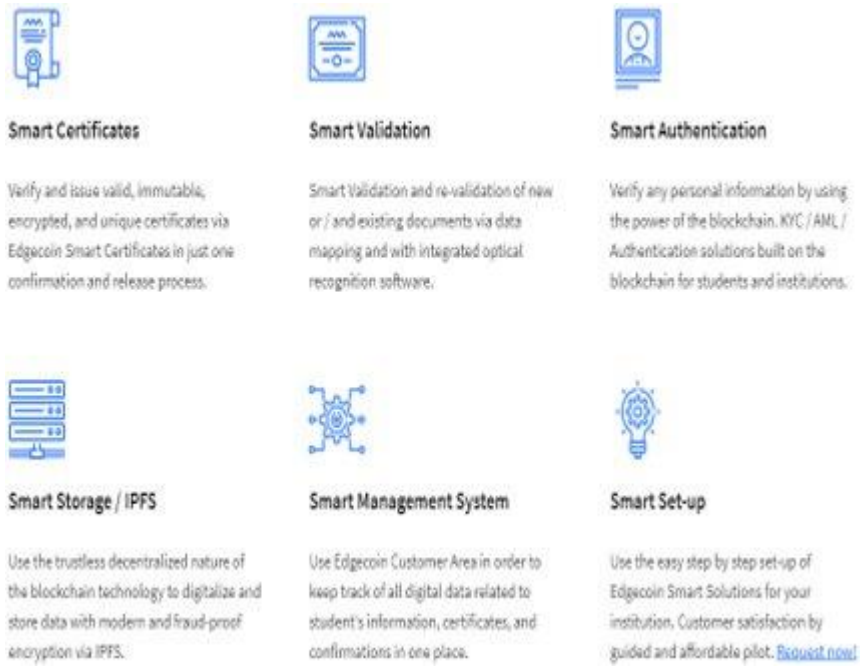

***Figure 1: Blockchain services (Edgecoin (2019), Retrieved from: https://www.edgecoin.io/)***

Keyword in this picture is ”smart”. That means that with that technology there will not be paper trail anymore and everything would be digital. Blockchain is encrypted so there is no risk of fraud or that the data could be stolen from you. It is then a secure way to store these academic credentials and easy to access since a lot of these current solutions offer an app where you can access all your information.

## How it works

At first, the universities need to invite the student to apply for the course credentials. Once this is done, the student accepts the invitation and applies for the credential with his blockchain ID. For the system to work, each university would have a private key so they can sign that the student really has this credential. Then the credential verification link is sent to the student so he can store it in is digital wallet where no one can modify the information or the content, so it’s completely secure. Once the student has all of his credential on his profile, he can invite a verifier to check his credentials and make sure everything is good. Once it’s all verified, an invitation to the employers can be send so they can have access to the profile and see all credentials the student has. This picture below shows the steps I just described


***Figure 2: Verification process (Blockcred (2019), Retrieved from: https://www.blockcred.io/)***

## Pros of using blockchain as a solution

Using blockchain can bring a lot of advantages to the users. The bigger one would be the security of the process. This technology is known to be secure and fraud-proof. Another good thing about this way of doing things is the paper

trail would be eliminated since everything would now be digital. Having everything electronically can also make the transfer of information much faster than having to send a paper document. Also, the cost of documents storage is also gone. So, to summarize here are the major pros to use blockchain to eliminate academic credential fraud:

- Safe
- Allows to save time
- Cost-effective
- Easy to use
- No paper trails

### Challenges of the blockchain as a solution

The major challenge right now for this technology is the price. There are a few solutions to be use by student, but it costs a lot of money. So, if you can't afford it well you can't use the blockchain as a credential platform. Having this accessibility problem cause the fact that if it's not used by everyone, the risk of fraud will always be there. To be sure that every student has access to this technology would cost a lot of money to the universities. For now, as it is stated here, the biggest challenge for this technology is the price of the service.

## HOW SHOULD BLOCKCHAIN WORK INTERNATIONALLY

In order to make the use of blockchain a viable option when it comes to verification of credentials, it is essential that this works internationally. However, this is something quite challenging because this technology faces a scalability problem. In the following section we will cover quickly what this problem is as well as discuss about the possibilities that could enable blockchain to work on a bigger scale and then we will discuss with some advantages of having it.

First, the scalability problem is something common for all blockchain solutions. You have probably heard about Bitcoin in the recent years has it got a major boost of popularity and value, well their blockchain can process a transaction about 370 times slower than Visa can process a transaction. This is a problem when it comes to exam periods as the transaction level in an educational context isn't constant all over the year. It is concentrated in different periods of the semester according to whether courses only have final exams or if they also have midterms. This will be the most demanding periods and if we compare to Bitcoin

who processes 4.6 transactions per second, well this could mean the time to upload grades can be longer than expected. Students could argue that this shouldn't be a problem as teachers all have different schedules, take different lapse of time to correct exams and don't enter their grades at the same time. This is partly true but we are looking at a solution that wouldn't be so beneficial on a small scale so having a solution that doesn't process quickly means that on an international level, this could cause an overload of the system or major delays during some periods.

Secondly the technology is quite complex, and options are being evaluated in order to scale blockchain solutions. Most of the blockchain solutions concern cryptocurrency and different options are being tested out to make the transactions faster and cheaper. A concept that looks promising in order to tackle this problem is the use of sidechains. A sidechain is basically a blockchain linked to a main blockchain but operate on a different network. This allows faster transactions at lower costs and therefore, should help the scalability problem. If we translate that to the credential verification solution we want, there could be a main chain between different education systems on a national level, for every country, and the educational institutions within these countries would complement this main chain by being on a network of sidechains.

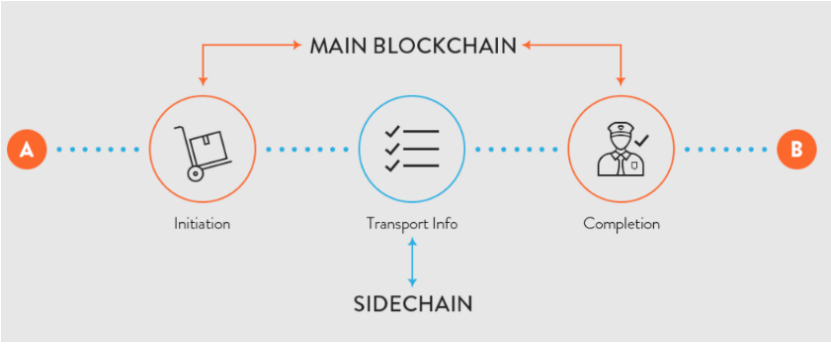


***Figure 3: Blockchain Scaling – Sidechains (2019). Retrieved from https://medium.com/***

The only problem to this solution though is that it needs a two-way peg design between the main chain and the side chains. As we are not experts in this field,

it is hard to determine is realistically, a centralized two-way pegs design should be used over federated two-way pegs. Therefore, it will be easier to explain what the outcome of each actor in this should be. The main chain should be for the students as this concerns them the most. The sidechain should be where the teachers are as they will provide the information necessary for the educational transcripts and data. Who is the entity that is in-between is questionable. It could be the educational institutions who would confirm that this teacher from the sidechain is giving this transcript of records to this student from the mainchain. This would be the easiest way to visualize it. In this case, the use of a centralized two-way peg should be the simplest way to proceed and also the fastest for the blockchain solution. There is still the question of who in the educational institution is trustworthy enough and impartial to approve these grades, but this is a fair question that concerns the current system as well.

This blockchain solution must work on an international level in order to really benefit the industry. To simply verify the credentials of a student from another province wouldn't be a good justification to the price of this solution. This should ease the process of workers going abroad as it would make it easier to verify their accreditations and also for students to study abroad. There are a few add-ons that can complement this technology in this case. Having the educational records of everyone, this should allow better transparency between businesses and workers. Therefore, with the use of algorithms, there could be a recommendation system when a business is looking for a candidate and vice versa when a worker is looking for a job.

## BLOCKCHAIN HIERARCHY FOR THE EXISTING SOLUTIONS

For a given blockchain, there are several kinds of users. Each has different permissions and different roles to play in the blockchain.

In most existing solutions, the three main roles are:

- The issuer. In our case, it represents the university from which a certificate comes from. The issuer takes a certificate, makes a hash (a unique chain of characters that represents a given certificate), and then it issues a transaction, asking for an empty block to store the certificate, using both its hash and the complete certificate. In some educational applications, for example “Blockcerts”, the issuer has the right to revoke a certificate and remove it from the blockchain, if it contained an error for example. This is done by keeping a list of revoked certificates, independent from the main blockchain. Then, to verify a certificate, their solution will first query the blockchain to see if the certificate has been issued once, and if it has been issued to the given student. Once this step is done, there is another query to the revoked list to see if the certificate is still valid. This solution is a workaround to one of the main principles of blockchain: a transaction is supposed to be completely immutable.
- The recipient. It is here the student that graduated or passed the exams to get a certificate. He will be the recipient of the transaction issued with a given certificate.
- The viewer. In our case, it corresponds to the managers and employers that are willing to verify a given certificate for a given student. This viewer has to pay the minimal transaction cost to issue a request, that will be able to retrieve any certificate from the blockchain.

Even though the hierarchy is quite straightforward, the main point is to determine how the issuer’s permission is given. For example, in one blockchain system, there is no way to verify that the issuer is legitimate. As not only the schools are able to issue certificates, it is not a reliable system. The point would be to either have a closed circle of institutions, that would be able to issue a certificate, or create a trust/reputation system: if the issuer is linked to a renowned school group, and the certificate is linked to the same school’s group, then depending on the amount of issuers and certificates this school owns and issued, one would

be able to compute a “trust”, “reputation” rank to ensure that the issuer is legitimate.

## A LOOK ON TRANSACTION COSTS

When using blockchain, every transaction (read or write operation on the blockchain) has a cost. The reason is that blocks in a blockchain can only contain a limited amount of transaction (in our case, for education, it may be credentials, diplomas...). Once the block is full, a new one must be created, by solving several computational problems.


Figure 4: Transaction costs illustrated (2018). Retrieved from ***https://en.bitcoin-wiki.org/***

Those transaction costs are computed depending on several factors:

- Complexity. The bigger the blockchain, the harder it is for miners to create a block, and the more expansive it is to create those new blocks. Hence the transactions costs will increase little by little.
- Priority. Miners tend to mine at first the blocks that rewards the most (i.e that has the highest transaction fee, as miners get a small percentage on those fees). If a transaction needs to be handled with a higher priority, the sender can increase the transaction fee he is willing to pay, so that its operation will be placed higher in the “priority queue”.

- Finally, Token Value. This is the simplest factor: the transaction costs increase depending on what you are trying to transfer. If we take the example of cryptocurrencies, the transaction would be more expansive if one token of this currency is worth 1000$, and cheaper if it is worth 10$.

The difference with an Education-oriented blockchain, is that the blockchain requires way less insertions: people usually don't get more than a few diplomas or certifications, compared to a currency blockchain in which they would be able to register transactions every day. However, as exposed in the 3rd part of this report, the educational blockchain will register high usage spikes during the examination periods. As a result, there may be more demand than created blocks during those spikes, which would end up in long priority queues: the transaction fees could be quite high during those periods.

However, this issue could be tackled depending on the implementation of the blockchain. In some existing solutions, certificates are stored in the blockchain without any pre-processing. In that case, it is a lot of memory that is lost. Some implementations of blockchain (for example the Bitcoin blockchain) use different compression functions, the most common one being the use of Merkle Trees.

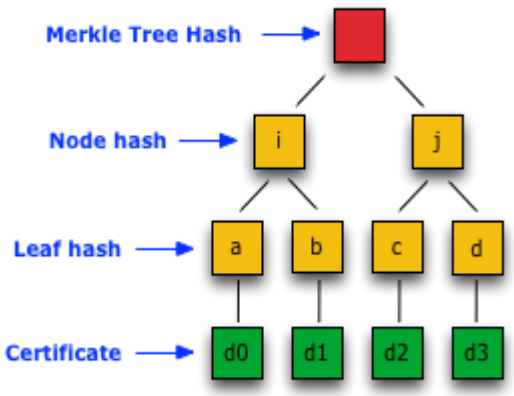


Figure 5: Merkle Trees principle. Retrieved from ***https://www.certificate-transparency.org/***

Those trees allow you to store several certificates in a single data structure. It is a lightweight way to store digital documents: the hash of a given certificate is

enough of a proof to know that it is genuine. This way, one could store up to four times more certificates in a single entity and reduce by the same amount the number of blocks that have to be mined. This implementation has a good impact on helping to reduce the transaction costs. Also, “read” operations on the blockchain do not require to process a huge amount of memory, as you will only need the hash back when doing a verification request.

For instance, the Blockcerts solution uses this kind of trees to send certificates: they issue every certificates inside batches, that represent groups such as “Students who graduated from X course, X year”. This way, every leaf of the tree represents a student, and you only have to do one blockchain transaction for a complete batch.

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# CONSUMER AWARENESS OF PRIVACY ASPECTS IN AR MOBILE APPLICATIONS

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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## ABSTRACT

Lucie Klus, Roman Klus and Ciaran Maguire:
CONSUMER AWARENESS OF PRIVACY ASPECTS IN AR MOBILE APPLICATIONS
Technology: Augmented Reality
Context: Privacy awareness of AR mobile game players
Lens: Investigate and conclude the awareness of the public sector

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This report targets the topic of user privacy awareness in mobile AR games, focused on answering the research question, whether the mobile application users are aware of the privacy risks the emerging technology presents. This work includes the market analysis and literature review on the topic. To answer the research question, the survey was created, distributed and evaluated with total of 1329 responses, focused on Pokémon GO community. The evaluation concluded, that the awareness of public sector regarding privacy policies is very low and that players are willing to sacrifice part of their privacy in order to play the game.

Keywords: Augmented Reality, Crowdsourcing, Pokémon GO, Privacy, Survey

## INTRODUCTION

Today, almost all of us sacrifice part our privacy, so that we can enjoy the benefits of modern technologies such as the internet, mobile phone applications and computer games. However, with the emergence of augmented reality, the amount of privacy we will have to sacrifice in order to fully enjoy its benefits will increase almost exponentially as the technology develops.

This arises an issue, since augmented reality (AR) applications collect much more data than regular ones. In order to augment the reality, the applications must collect large amounts of data about “our reality” in order to perform the task of creating and augmenting the perceived environment around the user. There are various data that VR applications gather, some of them are relatively harmless in scope of user privacy as cookies, but some could pose more serious risks as biometrics of the user.

The technologies such as smart speakers, including functions like AI personal assistants, operate essentially as always-on microphones. These types of de-

vices collect lots of real-time data, which many people consider to be quite personal. These types of data can easily be misused to harm the user, in case they were stolen by hackers, sold to malicious private companies or in extreme cases acquired by foreign governments. An example of large-scale privacy violation as of 2019 is (Risk Based Secruity, 2019), where 8 individual data breaches exposed an estimated total of 3.2 billion personal records. This highlights an issue which occurs, when users blindly trust large companies with all their data. The databases of such companies are an easy target for attacks, since they contain millions or billions of often personal and sensitive records and their security is often outdated, as well as they can misuse the data themselves by abusing poorly written privacy policy agreements to the users.

Based on the above, this project addresses the underlaying problem of the consumers awareness with regard to AR applications and the privacy aspects connected with the topic. We targeted the specific application users, namely Pokémon GO players, as the group of interest as Pokémon GO is the leading AR application on current mobile platform market, as well as it is a global icon for AR. We created and distributed the survey in Czech and English languages which reached a total of more than 1,300 participants. We aimed to analyze this information and produce valuable insights from the results as well as note any trends in attitudes we discovered between the demographics of participants. We also produced a cursory report on the current size of the Augmented reality market on mobile games, as well as attempted to gauge the consumer interest in the topic of Augmented reality. We produced our report on the AR gaming market by compiling a list of the top AR games, we also noted any common themes which these top games share.

The report is structured in the following way. Section 2 describes the objectives of the report and the methodologies used to conduct this report, a brief market analysis report on AR Android gaming and awareness of the term augmented reality is presented in Section 3. Section 3 further includes a review of related literature and results of this literature. Section 4 lists the description of the survey we conducted as well as the platforms used to spread the survey and any methods not already discussed. At the end of the report is an analysis of the results of our survey followed by our conclusions of this report.

# OBJECTIVE

## Research questions

In the scope of this project, the following questions were highlighted as the targets.

- What is the AR games user's awareness level and knowledge regarding the policy agreement, data they are sharing and their privacy concerns?
- How do the answers differ based on the users':
  - Gender?
  - Age?
  - Country of origin?
- Based on the gathered information, are there reasons to be concerned? If so, what actions should be taken to address the issues?

## Methodology

Our methodology consists of several steps. In order to answer the research questions reliably, we first conducted a market analysis regarding AR mobile applications, with Pokémon GO as the most popular and distributed game (see Section 3). Secondly, we made an analysis of the scientific literature on the topic. The literature review did not find a conclusive answer to the research questions, although some sources already tried to answer them (e.g. due to the small number of participants or asking different questions). We also highlighted several important aspects and information about the user privacy and the game (see Section 4). Next, we aimed to create a tool, using which we will be able to achieve the set goal. To gather reliable sample of user opinions, we created a survey focused on Pokémon GO player community in two languages and distributed them to dedicated groups of active players (see Section 5). After gathering sufficient sample of responses, we analyzed the survey and present the findings (see Section 6).

# THEORETICAL BACKGROUND ON AR MOBILE GAMES

## Introduction to AR Mobile Applications

Below we have compiled a Google trends graph which shows the average interest of the search terms listed below. From what we can see, Pokémon GO is a much more popular Google search term than both virtual and augmented reality. This is quite unusual, as Pokémon GO is an augmented reality game. More interestingly, we can see the difference in interest between AR and VR. One likely factor for this large difference is the fact that VR has attracted much more media interest compared to AR, as well as AR is having a much smaller market and adoption rate sitting at an estimated 10.7 billion USD worldwide as of 2019 (Virtual Reality Market by Offering, Technology, Device Type, and Geography - Global Forecast to 2024, 2019) compared to a global VR market of 11.52 billion USD. This lack of interest in AR is likely coupled to the fact that consumers remain quite unaware of the technology, even to the point that users are unaware of the term while using it.

Numbers in Figure 1 represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. A score of 0 means that there was not enough data for this term. More thorough analysis can be found in (Compare, 2020).


***Figure 1 Interest over time in Google search on AR, VR and Pokémon Go***

Figure 2 represents the market share that the top five AR mobile games have. From this chart as far as AR games go Pokémon GO is by far most popular. Pokémon GO is developed by Niantic, which also developed Ingress Prime and Harry Potter: Wizards Unit, which are all in the top five AR games. From this we can clearly see that Niantic is the main innovator in AR Gaming across mobile

platforms. This market domination by Pokémon GO is a key reason why we based our survey on Pokémon Go, as this game gives a larger and more representative base of respondents.

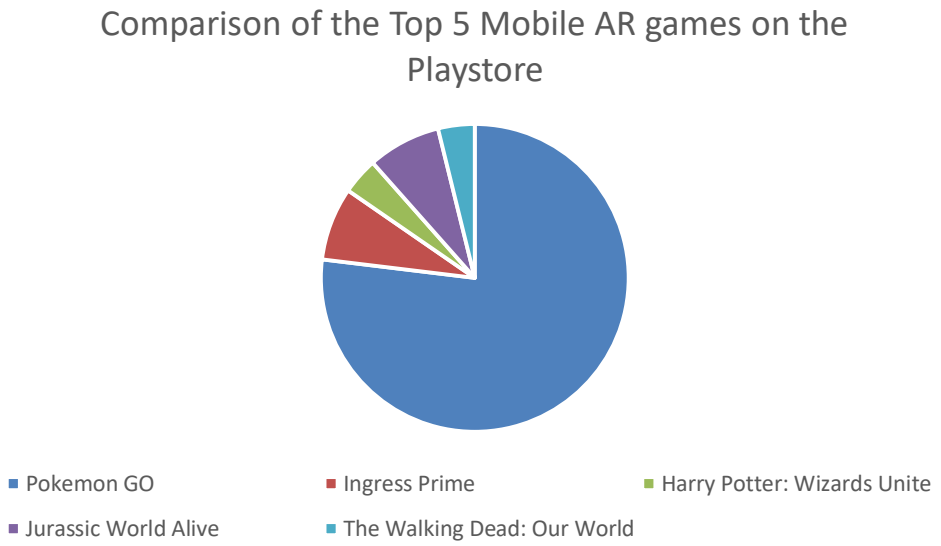


***Figure 2 Comparison of the Top 5 Mobile AR games on the Play Store***

## AR Game Features

The main AR feature in **Pokémon GO** is the map overlay, which is a real-world map filled with catchable little creatures called Pokémon. The user can catch them “in the real world” by turning on the AR feature, meaning he may activate the mobile camera and overlay the view with a Pokémon. The user can also feed their buddy Pokémon in AR scenario, play with it and take photos of it. A special AR+ mode allows the Pokémon to appear on a flat surface in the camera view, where the user can feed it or take pictures of that Pokémon in even more realistic environment, allowing for certain interactions with the player. The map in all Niantic Games is traversed by moving in real life.

**Ingress Prime** was the first AR game that Niantic developed and the development for this game laid the groundwork for Pokémon Go. The Main AR feature in this game is the world map, which serves as the play space for the game and operates basically the same way as Pokémon GO. Ingress Prime has the most encouragement for in-game communication and collaboration out of any Niantic

games, mostly due to the way the game was designed as a type of capture the flag game.

**Harry Potter: Wizards Unite** is another game developed by Niantic which is very similar to Pokémon GO with the main difference being the theme. This game is location based and has the same level of AR imaging capabilities as Pokémon Go, although instead of AR imaging the Pokémon, it has ‘Confoundables’, which simply operate as Harry Potter themed collectables items.

**Jurassic World Alive** is a location-based game which has a map as its main AR feature. Users also can take AR images and videos with dinosaurs. **The Walking Dead: Our World** is centralized on location-based gameplay as well. The player can traverse with the map by moving in the real world, gathering resources and fighting zombies. It also has player messaging, making it the most social AR game out of the mentioned. It is quite surprising that this is the only AR game in the top 5 with an in-game messaging feature.

Based on the market analysis, it seems that most of AR-based games are location based with the map overlay and share many common features. This highlights the need for more AR gaming feature development. The lack of of-the-shelf AR features is caused by limited performance and battery capacity of the mobile devices. This analysis also supports our choice of Pokémon GO as the game platform to conduct our survey on.

Another aspect to take into account is that Niantic has one privacy policy for all products (Niantic Privacy Policy, 2019),

## Related Literature

In the section below the current available literature relating to this paper is discussed. The chapter focuses on the literature on the topic of privacy awareness in mobile applications supporting AR. (Elahi, Wang, & Xie, 2017) addresses the issue of smartphone data over-collection in smartphone devices. The work addresses the issue of lack of regularization in many countries, leading to possible serious privacy violations using mobile application. The paper also presents the results of two surveys distributed among 100 and 44 university students respectively regarding privacy awareness, concluding that pictures, videos, messages

and contacts have high privacy values to the users. Also, that numerous users are unaware of the permissions they are giving to an application, majority of subjects did not read the end user license agreement (EULA) and that vast majority is uncomfortable with distributing their personal information by third parties for financial gain.

A study focused on localization data (Patel & Palomar, 2014) shows, that both 3GPP and IETF have standardized rules for privacy when handling location-based data by mobile applications, but discover several aspects in Layers 1, 2 and 3 that need to be addressed further.

A case study on AR and privacy in augmented reality application Google Maps (Zhang, Slavin, Wang, & Niu, 2019) shows, that there are no mechanisms in Android systems checking, whether the data the application is collecting is necessary or not and that AR applications are allowed to extract all data from the allowed sources, without any supervision.

A report on two surveys (683 and 200 participants, respectively) regarding Pokémon GO and privacy in Germany (Harborth & Pape, 2018) presents, that older players have higher privacy awareness in comparison to younger participants. The work also concludes that although there are privacy concerns within the community, they do not affect the players behavior in the game. Although the majority of players is aware and concerned about the privacy risks, playing the game provides sufficient advantages for them to disregard the concerns. Nevertheless, the surveys were conducted on homogenous subject group, not ever representative for German population, making the results of the survey somehow inconclusive.

Another survey distributed among 208 people, from which 54 were Pokémon GO players was evaluated in (Braghin & Del Vecchio, 2017). The paper summarizes all the permissions, that Pokémon GO requires, namely in-app purchases, identity accounts on the device, contacts, location, media files, internet access and full Bluetooth access. The survey was focused on the young population, from which 45 % claim they have read privacy agreement before installing an application and 6 % claim they did not accept the privacy policy.

In comparison to the work mentioned above, our survey contains more than 1300 responses only from dedicated Pokémon GO players from 5 different continents

and contains multiple choice answers, as well as open questions where the participants could share their opinions on the topic.

## DATA GATHERING

As a part of the project the survey among the players of Pokémon GO was conducted. In this chapter, the methodology of creating and distributing the survey is described.

The survey was created in order to crowdsource data from the Pokémon GO community to answer the research questions stated in previous chapters, gather basic information about the questioned subjects and in the process ask about additional opinions and remarks regarding the topic. It was first created in English, then translated to Czech language to be distributed among the local communities in Czech Republic and Slovakia.

In the first part of the survey the questions are aimed to assess the information about each player, such as for how long the person plays the game, how advanced he is in the game, gender, age and the country of origin. Second part of the survey is focused on the player goals and preferences in the game. This part was not evaluated in this report in order to focus on the privacy aspect. The questions in the third part address the privacy aspects of the game and player knowledge and concerns regarding them.

In order to receive sufficient number of answers to the survey as well as to control their quality and worth, we approached the player community only. The aim was to distribute the survey only among the dedicated players to reduce the number of false, misinformed or misleading answers, which is why only the channels for dedicated Pokémon GO plyers were used when sharing the survey. As the authors are active players with contacts across multiple countries, the known Telegram and WhatsApp community channels were the first targets for the survey. Secondly, multiple Facebook groups, gathering players in various countries and cities were contacted to submit their answers, as well as global Pokémon GO groups, e.g. Pokémon GO Worldwide (Official).

In total, we received 1075 responses on English version of the survey and 254 responses on the Czech one, summing up to the 1329 responses in total.

## SURVEY ANALYSIS AND RESULTS

This section presents and analyses the results of the survey. The first part shows the demographics of the responders including country of origin and gender, as well as their advancement in the game. Next, the overall results of the survey are described assessing the global view on the studied aspects. Finally, the statistical differences of responses between the chosen groups of responders are highlighted, namely by gender, country of origin and age.

Figure 3 shows the distribution of responders based on the continent they come from, with the most answers from Europe, followed by North America, Asia, Australia and Oceania, Africa and with 11 answers from South America.

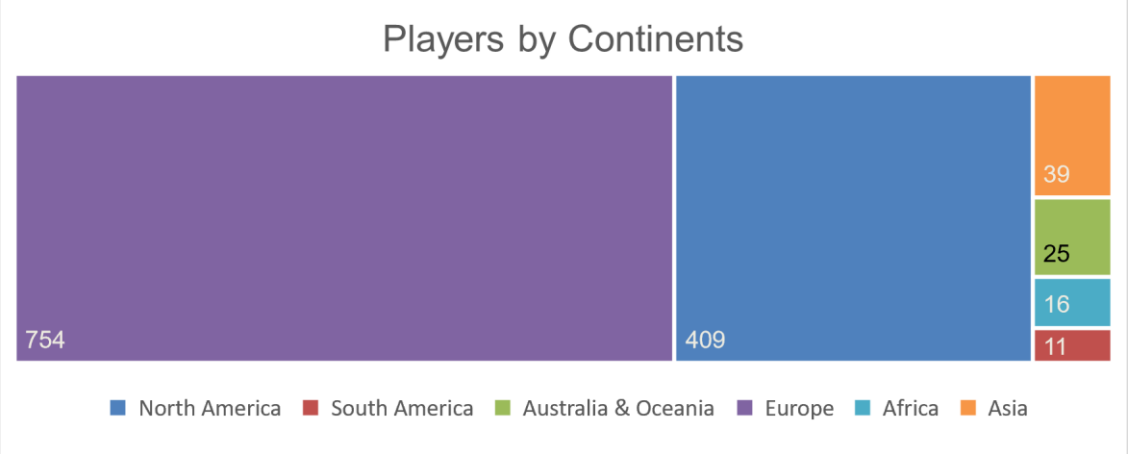


***Figure 3 Player distribution by continents***

Country-wise, the highest number of answers is from USA (319 responses), followed by Czech Republic (177), Finland (173), Poland (140) and United Kingdom (81). The most answers from Asia are from India (18), South America is represented mostly by Peru (3), Africa by South Africa (16) and Australia and Oceania by Australia (23). The five countries with the most answers are considered in the by-country evaluation below.

Figure 4 presents, that 39 % of the responders were male, 58 % female, 1 % other and 1 % preferred not to say. The figure shows, that the Pokémon GO game is vastly played by female players, also that the females are more willing to participate in surveys.

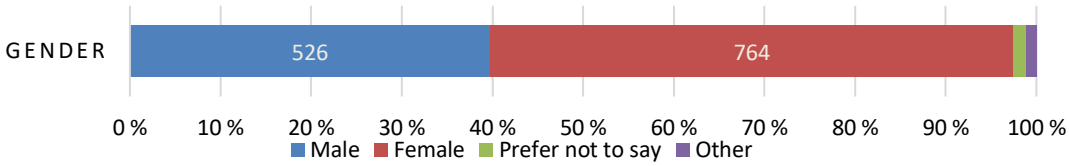


***Figure 4 Player distribution by gender***

The age of the responders is summarized in Figure 5, which shows, that the highest number of responders are between 26 and 35 years old, followed by the group of 16 to 25, 36 to 50, and the group of more than 51 years old got respectful 84 answers. The results show, that the Pokémon GO game is enjoyed mostly by adult people, who have most probably fallen for the world of Pokémon franchise when they were children, as it began in 1995 as the games for a popular console, Game Boy.

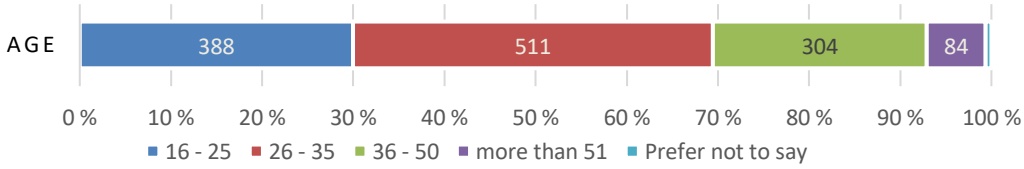


***Figure 5 Player distribution by age***

Figure 6 shows, that the strong majority of the players, over 80 %, play the game for longer than a year. These data prove, that the answers on the survey are given by experienced players, who have tested all the aspects of the game and are able to provide constructive feedback.

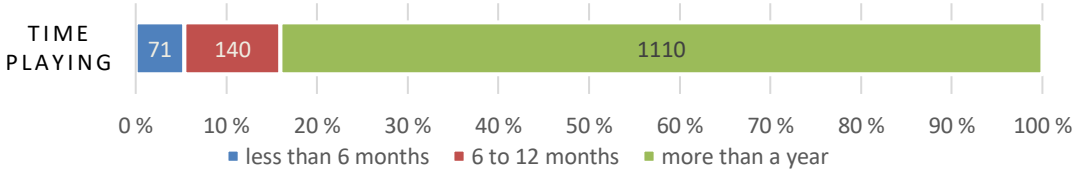


***Figure 6 Player distribution by time they are playing the game***

Figure 7 confirms the findings of the previous one. The majority of players are above level 37, reaching which takes at least a year to a casual player (claim based on personal experience of authors).

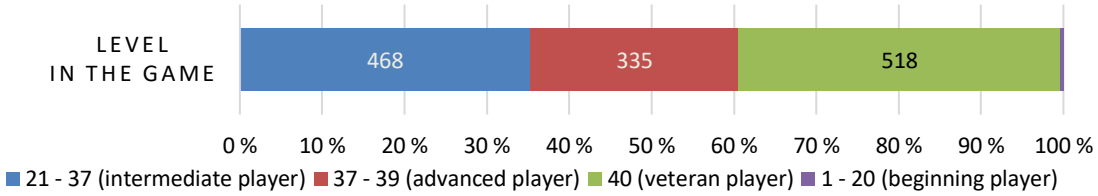


***Figure 7 Player distribution by their level in the game***

Figure 8 is targeted on answering the user concerns regarding the application having access to various privacy-sensitive data on their smartphones. The results show, that in the majority of cases the responders chose the non-extreme answers, about either trusting the application, neutral opinion or enjoying the game. The highest concerns in the community are when giving access to the contacts, followed by gallery and camera.

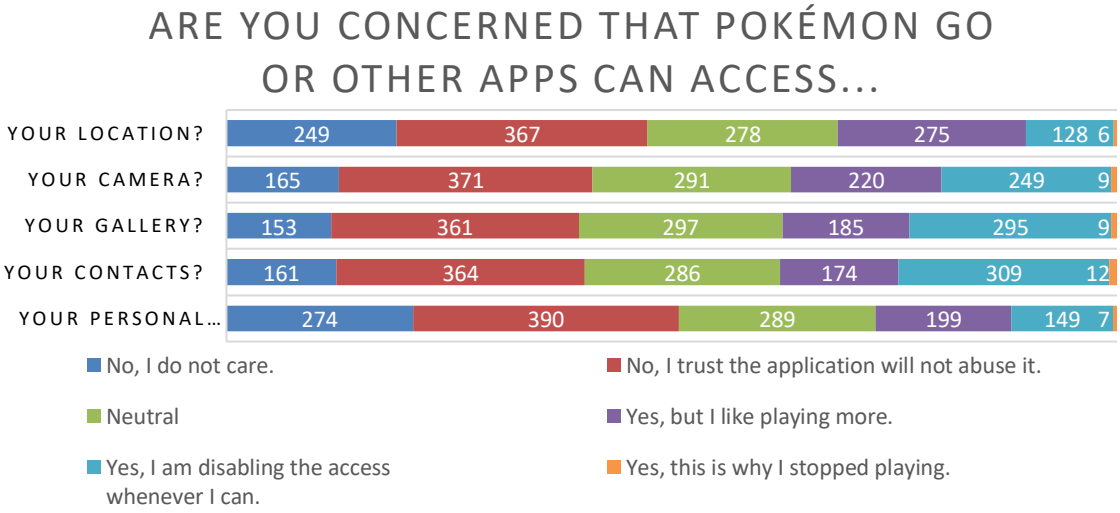


***Figure 8 Player concerns regarding sharing personal data***

Figure 9 shows the responses about how often are people concerned or aware of sharing their private data through the applications. The results suggest, that topic sometimes comes to mind for the majority of responders but is not their everyday concern.

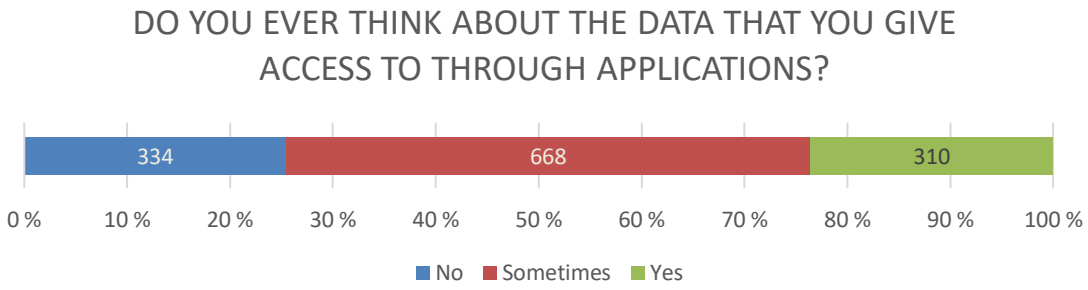


***Figure 9 Players concern status***

The answers presented in the Figure 10 show, that the majority of people did not read the privacy policy of Niantic before installing the game or while playing. On one hand this can be considered irresponsible, on the other hand the privacy policies are often purposely written in very unclear manner, resulting in bigger confusion after reading them than before.

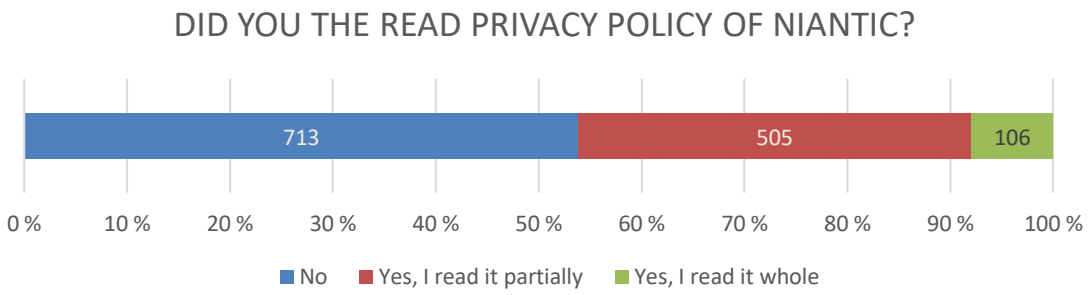


***Figure 10 Player answers regarding reading the privacy policy agreement***

Figure 11 compares the differences in answering patterns between male and female responders regarding their concerns regarding personal data access. The figure shows, that male responders are less concerned, while the majority of female responders thinks about the issues sometimes.

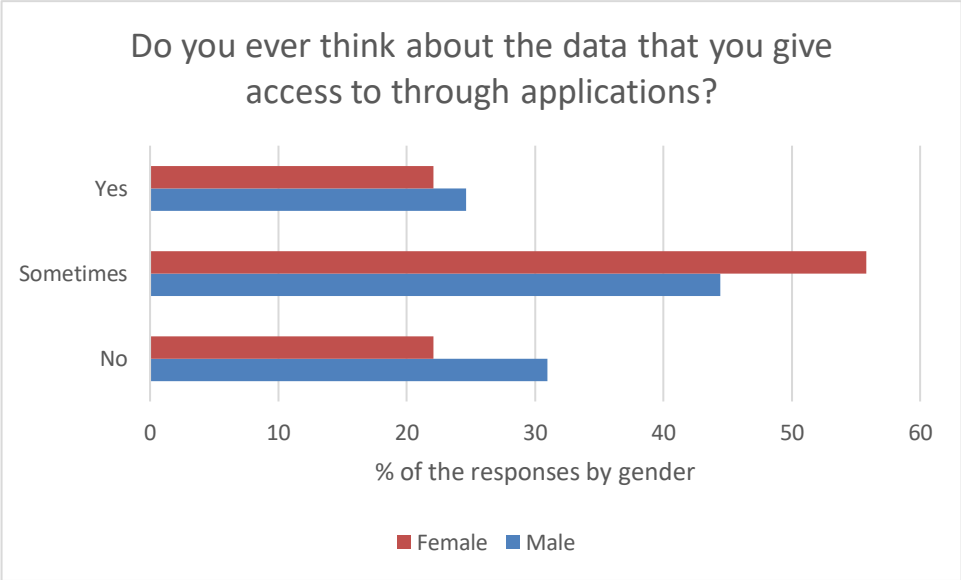


***Figure 11 Gender differences, concerns regarding access to personal data***

Figure 12 shows, that there are almost no differences between male and female responders regarding their privacy policy reading habits.

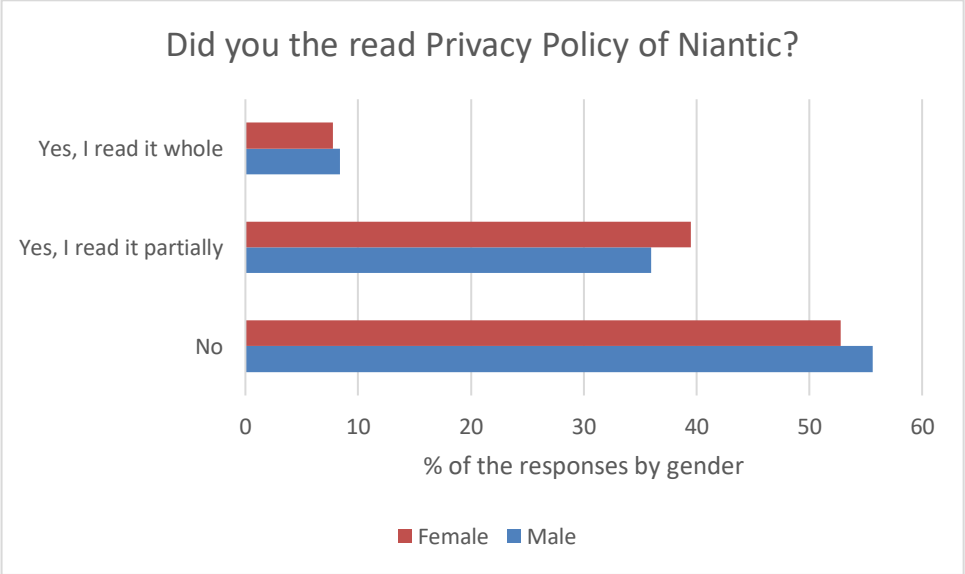


***Figure 12 Gender differences, privacy policy answers***

Figure 13 shows, that with the increasing age, the responders are more likely to read the privacy policy when using an application. This might be caused by higher awareness of adult people in regard to their personal data, as well as by higher uninterest or ignorance of younger generation when it comes to these topics. This finding confirms the results presented in (Harborth & Pape, 2018).

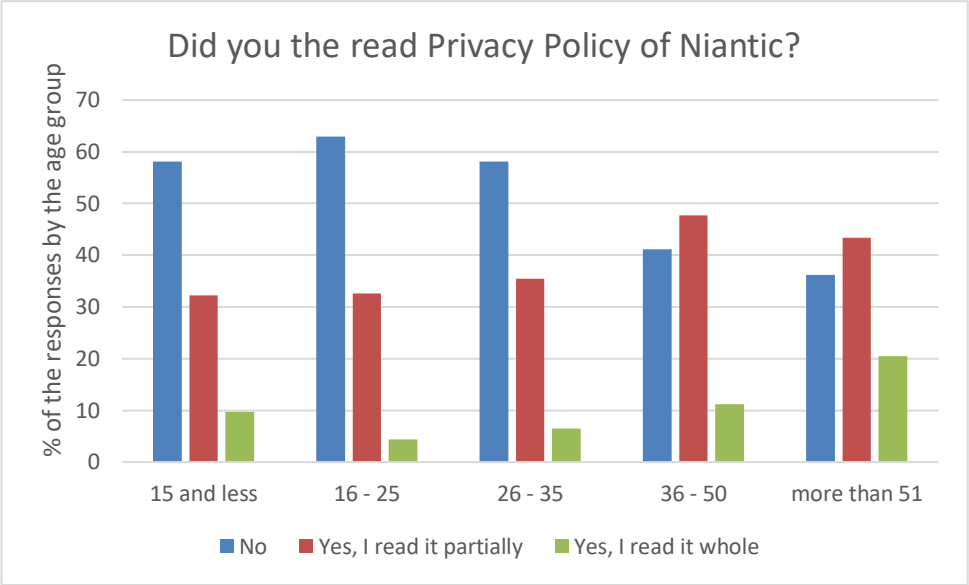


***Figure 13 Age differences, concerns regarding access to personal data***

Figure 14 shows the answers regarding the awareness and concerns, when it comes to sharing personal data based on player age. Older players answered "Yes" more often than the younger people, with over 40 % of responders younger than 15 answering "No".

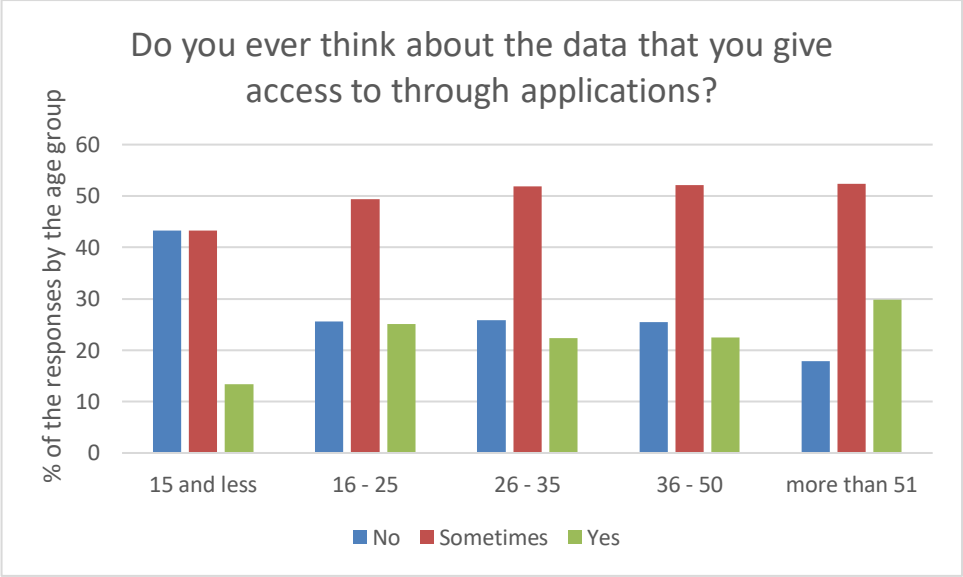


***Figure 14 Age differences, privacy policy answers***

The differences in player concerns based on the country of origin is shown in Figure 15. The figure shows rather balanced answering patterns, with Czech Republic being significantly less concerned than the rest.

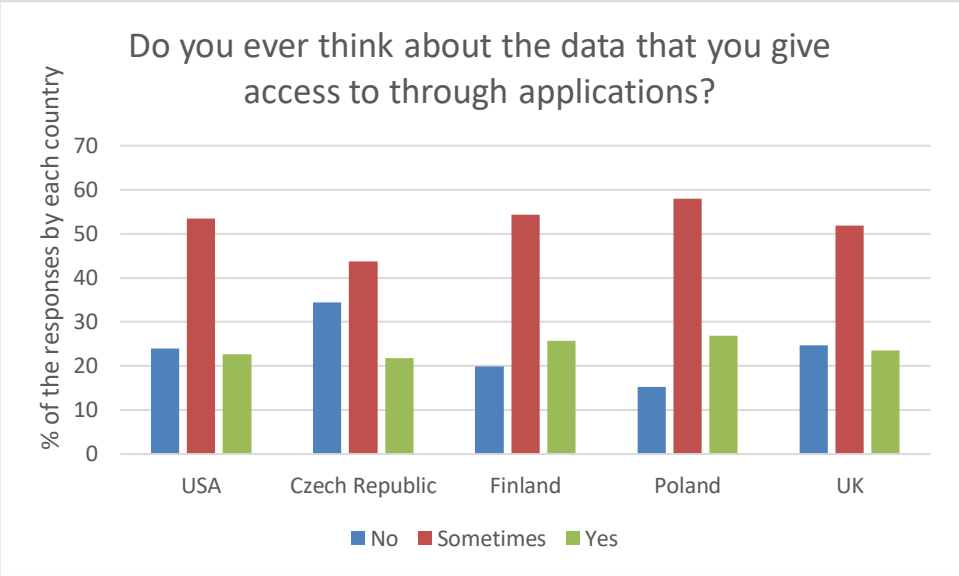


***Figure 15 Country differences, concerns regarding access to personal data***

The habits regarding reading the privacy policy agreement differentiated by countries is displayed in Figure 16. The statistics show, that over 60 % of Polish players and 59 % of players from UK answered “No”. Interestingly, 12 % of players from USA claim they have read the whole privacy agreement.

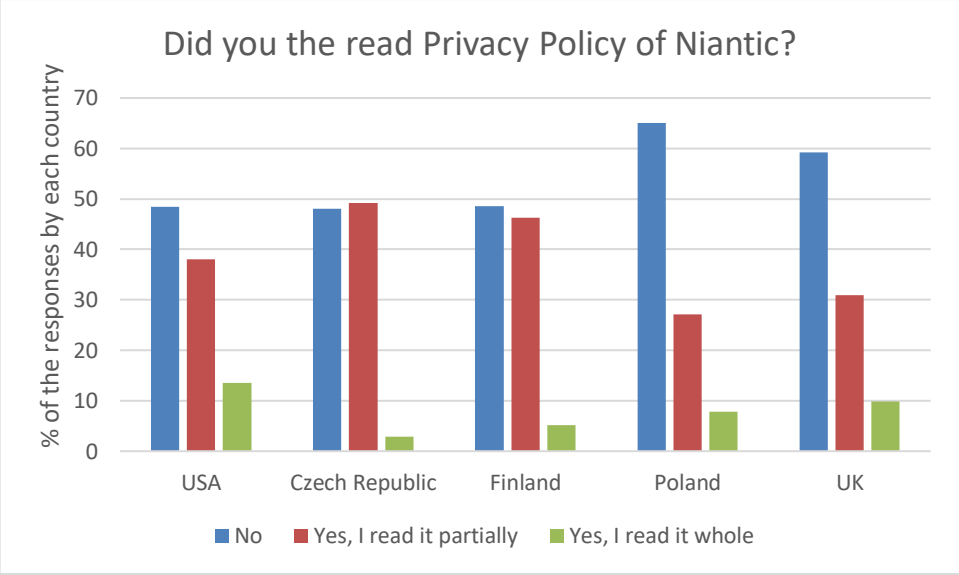


***Figure 16 Country differences, privacy policy answers***

## Result summary

This section presents the answers to the research questions of this report. The survey results show, that the user awareness level and knowledge regarding the

privacy agreement are on average very low. The concerns the responders share regarding sharing their personal data are in majority of cases diminished by the advantages the game offers to them.

The survey also concludes, that men are less concerned about sharing personal data than women and that both genders hardly ever read privacy policy agreement. The survey further shows, that older players are more aware of privacy agreement and more protective of their personal data. The answers are also slightly different based on the country of origin of the responder, yet overall they comply with each other. The most privacy aware nation was found to be USA, from which 12 % responders read the whole privacy policy agreement. These findings may be useful for the advertising and marketing purposes, as well as should be taken into consideration when creating a software for a specific group of people. Gender and age-specific behavior of user should be addressed further in research in order to distinguish specific behavioral patterns.

Based on the results, we conclude that the users are happy to sacrifice part of their privacy in order to play the game they enjoy, and that they are unaware of all the data and rights they give to the companies owning the mobile applications. The results of the report show, that the issue of user privacy should be addressed further by educating the population in the risks the AR-based applications and data sharing may bring.

## Comparison of the results to the claims in literature

The following paragraphs discuss the key similarities and differences between the reviewed literature and the findings of this report. Overall, the findings comply with the results presented in the literature, with additional key observations were either not sufficiently addressed or not addressed at all in the literature so far.

(Elahi, Wang, & Xie, 2017) results regarding the privacy awareness of the users as well as their habits of reading user privacy policy agreement agree with the findings of this report (see Figure 10). The high privacy level of the personal data is indirectly confirmed in Figure 8, which shows the highest privacy concerns are regarding contact data, followed by the gallery files.

The survey also confirms the findings of (Harborth & Pape, 2018) regarding increased privacy awareness among older people, as shown in Figure 13 and Figure 14. The findings of the survey are additionally based on large sample of responders across all age groups. The claims regarding the player's willingness to sacrifice the privacy for the sake of playing a game are also confirmed (see Figure 8).

The results regarding the players reading the privacy policy agreement from (Braghin & Del Vecchio, 2017), stating that 45 % of young players read them does not agree with local results, which claim that less than 10 % of the people younger than 25 years read the EULA (see Figure 13). The bias was probably caused by the homogeneity and the small number of responders.

## Discussion

In this section, the additional remarks, shortcomings of the realized work and possible future improvements are discussed.

The realized survey is the most extensively answered survey on the topic with regard to reply count and responder diversity and specialization, as far as the best author's knowledge is concerned. Nevertheless, several aspects must be addressed concerning possible drawbacks.

First, as the survey was distributed online and was fully anonymous (no personal data including user IP etc. were collected), the identity of responders is unknown. It is impossible to determine, whether there were multiple answers from a single responder or whether the responders were lying about their whereabouts or opinions. Nevertheless, the specified targeting of the responders increases the trustworthiness of the answers, as the player community is united and supportive towards each other.

Secondly, the claims from the survey might not be applicable to all AR-based applications, as only the Pokémon GO players were targeted. It is safe to assume, that the players of the similar games on the market (addressed above) will behave and think similarly or the same, but the whole audience of the AR is much broader (applications such as Google Translate have little in common with Pokémon GO).

The authors would also like to extend the current work, along with publishing the full data collected from both surveys. If possible, the authors would like to publish both raw data, as well as processed data including filtering, translation of Czech responses to English, prepared scripts for analysis etc. Additionally, more thorough analysis targeting the specific aspects in the survey is planned, as well as the analysis of the open question answers. In order to do so, the specialized group focused on gamification theory will be contacted to assist with the proper targeting and scientific methods.

**The key take-away points** from this report are as follow:

- AR-based mobile games nowadays have limited immersion of the AR technology
- Games and applications have strong and dedicated communities around the world, that cooperate on social media
- Crowdsourcing can be efficiently utilized by addressing such communities on social media directly in order to achieve high number of valid responses
- Only a small part of global community reads privacy policy agreement and knows what data they share
- Players are in general willing to sacrifice part of their privacy in order to gain benefits from the applications
- Older people are more privacy-aware and protective of their data, whereas younger responders are not concerned of their privacy
- Women are more privacy-aware and protective of their data than men, which is the important conclusion and should be further addressed in research.
- Privacy awareness should be addressed in education, as the general public is widely unaware of the challenges and risks connected to the topic

## CONCLUSIONS

In scope of this report, the privacy awareness of people using AR mobile games was addressed. The main research question of the report is to answer, whether

the AR mobile gaming community is aware of the privacy policies they accept and what is their opinion on giving access to their personal data.

First, the market analysis of the AR mobile games was conducted placing Pokémon GO as the most frequently played one. The literature review gathers valuable insight to the topic yet does not answer the research questions reliably.

The survey was created and evaluated, with 1329 participants in total. The findings show, that the majority of players do not read the privacy policy agreement, the concerns regarding giving access to personal information are balanced by advantages the application provides and that the issue of sharing the personal data sometimes concerns them, yet is not the most pressing one. The evaluation also shows the differences in answering patterns based on the gender, age and country of origin of the participants. The brief conclusion states that males are less concerned with sharing the data, older people are more aware of their privacy than younger ones and that the least concerned nation out of the evaluated ones are Czechs. The findings are also compared to the ones in the literature, agreeing in most cases. Further, based on the results of the survey the recommendation to educate the public sector in regard of the user privacy awareness is highly suggested. The main take-away points are highlighted at the end of Section 0.

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# ENHANCING ONBOARDING WITH AUGMENTED REALITY – CASE IKEA

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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Teemu Kontro
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## ABSTRACT

Teemu Kontro, Laura Karintaus, Tiia Eronen, Noora Raudaskoski

Technology: Augmented reality
Lens: Prescribe

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This research was part of the emerging technology adoption and use course at Tampere University. The subject of this research was the use of augmented reality on onboarding processes. Especially the focus was on onboarding new employees on large organizations that do a lot of similar manual work. The use case of this research was Ikea.

Research lens was prescribing, in which the research was done by literature review and market search which was reflected to the use case. The study also included three interviews, two Ikea employees with job descriptions that include onboarding tasks, and one non-Ikea worker, who was AR experienced person.

As a result, this research found possible AR technology concepts that could be used in Ikea's onboarding process. This research also provides prospects for the possible technologies on both tech and human-orientated point of view.

Keywords: Augmented Reality, Onboarding, Implementation

# INTRODUCTION

This research was carried out as part of the Emerging technology adoption and use -course at the Tampere University. The subject of the study is the use of augmented reality to onboarding new employees. The research focuses on organizations that do a lot of similar manual work. Onboarding with such organizations is often resource-intensive and may be too shallow, making work safely and efficiently difficult. Often, onboarding is the responsibility of supervisors or human resources, who are often already highly employed. Utilizing the augmented reality of onboarding could free up their working hours for more specialist jobs.

The study investigates the applicability of augmented reality technology to onboarding. The aim is to explore the benefits and resources that technology deployment could bring. The research question is "How can augmented reality improve the onboarding of new employees?"

The study first explored how augmented reality is currently being used in onboarding in different organizations. Literature and previous studies were utilized here. It was also considered how the technology could be used in new ways, and that help with onboarding would be needed. This was done using interviews with augmented reality technology specialists and case managers in the case organization. Information from interviews and previous research is applied to the needs of the case organization and the value of the solution to the organization is evaluated.

The second chapter focuses on onboarding. First, the objectives of the onboarding are introduced, and then the challenges of onboarding in many organizations are explained. The third chapter deals with the technology we have chosen, i.e. augmented reality. We will introduce how augmented technology has been utilized in the past for onboarding and various use cases. The fourth chapter deals with the onboarding of our case organization and its problems and the use of AR technology within that organization. The fifth chapter presents the future perspectives of augmented reality in terms of onboarding from both a technical and a human perspective.

# ONBOARDING

This chapter focuses on the goals and challenges of onboarding. First, we define what is meant by onboarding and what its goals are for the organization. Secondly, it describes the challenges of new employee onboarding, which are often encountered in different organizations.

## Goal of onboarding

The purpose of onboarding is to familiarize the new employee with the goals, values, rules and processes of their new job. At its best, a successful induction will result in the organization becoming a productive employee and a former colleague. There are four critical parts to a successful orientation process. The first is compliance, meaning that an employee is told the legal and other rules of the job. (Bauer, 2010) During induction, the new employee must acquire the knowledge and skills required to be productive and enter the work community. (Watkins, 2016)

The second part is clarification. The purpose of this is for the employee to understand the content of his new job and the goals involved. (Bauer, 2010; Watkins, 2016) The purpose of onboarding is to teach the new employee how to work in the organization and to understand their role in the workplace. The onboarding includes a variety of practices to help the new employee learn and assimilate workplace habits and job expectations. (Huselid et al. 2009, s.196-199)

The third is culture. It includes working community practices and teaching organizational standards such as values. (Bauer, 2010) Through the onboarding, the new employee also gets to know other members of the work community and the work environment. (Watkins, 2016) A good working atmosphere and supportive colleagues are a prerequisite for a meaningful job and successful management.

The last part is the connection. It creates the necessary networks for the new employee to work and encourages relationships within the organization. (Bauer, 2010) The extent and depth of the onboarding depends on the nature of the new employee's job and position within the organization. Thus, for example, the scope

and content of the onboarding of an industrial worker and a member of a specialist organization may vary widely. This work focuses more onboarding on manual work than on expert work.

## Challenges of onboarding

Onboarding in organizations is often seen as a mere cost and not an investment in the future. Poorly managed onboarding leads to loss of potential and inefficiency in work. A lot of time and resources have been spent recruiting a new employee. (Smart, 2012) Even with a poor onboarding, even a great choice is wasted because the new employee is unable to work at full capacity because he / she has insufficient knowledge to do the job.

Often in organizations the problem of providing proper onboarding is lack of resources and rush (Kjelin & Kuusisto, 2003, 241). Onboarding is often supervisor's or human resources responsibility. Often the superintendent is already highly employed and may not have the opportunity to arrange enough time for onboarding. The challenge of manual work onboarding may be the lack of practical experience of the instructor in these tasks Often, supervisors can do a very different job from their subordinates, so they may not have any practical experience of being a new employee. This can cause important issues to be overlooked in the onboarding and, consequently, the onboarding will be missed. This is also a problem with the orientation provided by HR as they may not have experience in practical work.

In addition to rush, problems with orientation may be due to lack of definition of responsibilities. The supervisor has not been able to coordinate the responsibilities in the orientation well enough, so important things can be missed. (Kjelin & Kuusisto, 2003, 243) It is good to have a clear division of responsibilities even before a new employee comes on board.

The instructor should be able to position himself as a new employee and understand how much support he or she needs. This can be challenging if the instructor has never been in a similar position or if a long time has passed. When all the little things are taken for granted, many of the things that are important to a new employee can easily be missed.

## AUGMENTED REALITY

Azuma et al. (2001) states that augmented reality, or AR, is a technology that is a mixture of a real and virtual environment. AR technology runs in real time and ranges objects with real and virtual world (Azuma et al, 2001). AR is part of mixed reality and can be seen in figure 1.

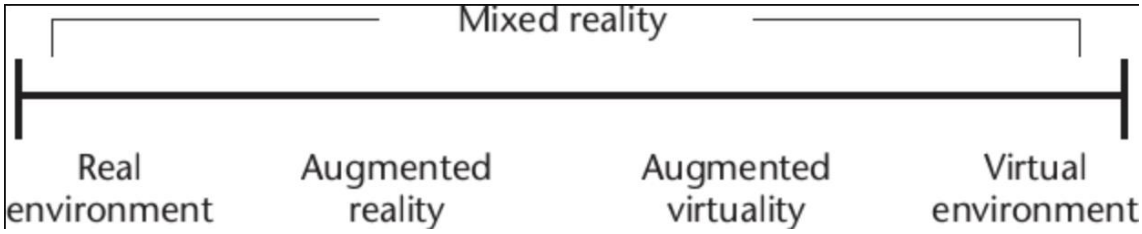


***Figure 1.*** *Mixed reality (Azuma et al. 2001)*

As seen on figure 1, while virtual reality applications allow you to be in the virtual environment, augmented reality adds virtual elements to the real world (Azuma et al. 2001). On the other words, augmented reality visualizes two- or three-dimensional virtual objects into real world (Milgram & Kishino, 1994). AR can be used in different displays for example head-mounted and hand-held displays (Azuma et al, 2001). However, the difference between well-known VR and AR is remarkable. Marr (2019) states that with VR, person is in the virtual world with head-mounted display. With AR head-mounted display, the display is see-trough and therefore person is always in the real world and can see everything around he or she (Marr, 2019).

### Using AR on onboarding

As said earlier, the main challenges with onboarding are lack of resources, the supervisor's ignorance when it comes the manual work and being a new employee and lack of time. How AR would solve these problems is by establishing the basic trainings and tasks that every employee should learn. With technology, the human-based problems such as supervisors lack of time and forgetting to teach everything decreases (Alptekin & Temmen, 2019). AR onboarding apps makes the quality of the onboarding process even.

In Alptekin's and Temmen's (2019) opinion, one of the biggest benefits of using AR is the visualization and therefore personalization of the product or service. When it comes to onboarding, the new employees positive feeling increase, when the onboarding process is well designed and personalized (Alptekin & Temmen,

2019). For example, comparing next situation: When supervisor takes rounds around the work environment with couple new employees and telling where they can find what. Or when the employees are given AR app which tells that specific person where she or he can find what she or he needs. The difference between personality and simplicity is remarkable.

## Implementation of the AR to onboarding

One of the crucial point of views is the actual creation process of the application, the main issue that we take a look at this paper is the implementation process. Even though AR is a technology that has been around for decades, it is still rarely used other than as entertainment. One aspect is the price of the technology, which is still quite high. However, despite the resources that are needed, using AR in onboarding and especially in a large company that does manual work rather than expert work, isn't that difficult in tech point of view as one would think. (XR specialist, personal communication, February 13, 2020)

Age range in a large company is wide. It is well known that older generations are not that familiar and used to try new technologies and apps. Alpkin and Temmen (2019) states that when it comes to AR, the more sophisticated the smartphone user, the easier it is to get to know and use the new app. Mindsets that are stiffened into old habits is not the best fit for learning new AR technologies. For example, if person is used to zoom the picture with fingers, in AR apps that doesn't usually work very well. AR apps are designed to be in a real world so the best way to go closer to some element is to walk closer. (Alptekin & Temmen, 2019)

When implementing any new technology, the process is always long and comes with unexpected challenges. However, even though the implementation might be difficult at the first, the benefits start to show early. One of the great benefits with AR onboarding app is the tracking and feedback (Yianni, 2018). It is easier to the supervisor and the new employee to follow the developments that happen daily basis. With weekly or monthly reports, company can improve their onboarding process to more efficient and simpler one.

## Existing AR onboarding solutions

There are numerous different AR devices and applications which can be used in employee onboarding. The simplest tools can be mobile device applications which do not require additional technology. One example of this kind of a training tool is Pointr: the software uses basic video call features in order to connect a new employee and a seasoned veteran who can point out specific things by using Pointr's AR visualizations through the trainee's phone camera view as shown in figure 2. The solution is simple and very easily scalable as it does not require customization for different tasks because the brain power required is already in the organization in the form of experienced employees. (Pointr.fi, 2020) While this solution does not require physical presence from the mentor, another person is still needed for the actual training.

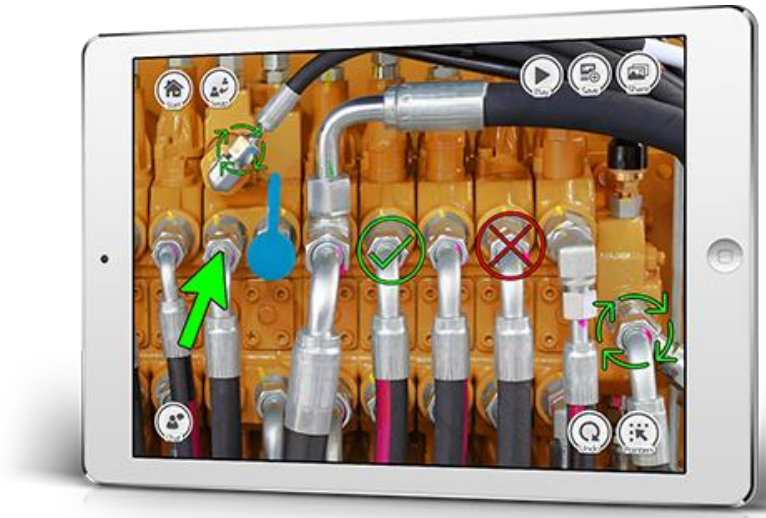

***Figure 2.*** *AR elements in Pointr (Pointr, 2020)*

Head-mounted displays (HMD) could offer more robust onboarding solutions. Simplest devices, such as Google Glass, offer a hands-free smartphone-like view for users. Microsoft HoloLens provides a more sophisticated HMD with a better display and real-time 3D positioning (Microsoft, 2020). The Glass Enterprise edition has been used in a few cases: DHL uses Glass for providing instructions straight to their warehouse workers' line of sight. (Google, 2020) ACGO Power utilizes Glass in their tractor motor assembling: an employee can scan a part in order to bring up a relevant manual, photo or video (Shamma, 2017). However, these solutions are not relevant for onboarding as they are used continuously in

order to improve efficiency in specific manual tasks. On the other hand, it could be possible to use a head-mounted display and an AR application as “training wheels” that are used to show new information to the employee until the person has memorized the information and can complete their tasks independently.

According to XR specialist (personal communication, February 13, 2020), highly customized AR onboarding courses are used in some cases where the benefits outweigh the costs, such as nuclear plants. However, the cost of creating an onboarding program like this are very high and thus unrealistic for ordinary tasks.

## CASE IKEA

IKEA is a Swedish furniture retail chain with around 400 stores in over 50 countries. The company has an organization-wide orientation program that is followed throughout. In this assignment, IKEA is involved as a case company in which context the research topic is applied. IKEA was chosen because its stores are relatively similar, the same products are sold everywhere, and there are a lot of standard things that should be taught to all employees. The aim is to explore whether utilizing AR in onboarding could be useful in an organization such as IKEA. The information in this section about IKEA and the needs and characteristics of its operations is based on interviews with two people working on IKEA’s onboarding. Individuals were sought to ascertain the current status and problem areas of the processes, as well as to seek views on whether an AR-supported application could be helpful in their onboarding. (Ikea employee 1 & Ikea employee 2, personal communication, February 2020) An XR expert was also asked to comment on AR utilization in IKEA onboarding. (XR specialist, personal communication, February 13, 2020).

## IKEA’s onboarding process and its challenges

IKEA has an organization-wide orientation program that every new employee goes through. Of course, there are differences in task-specific orientation, but there is also a lot of common content. Each employee has a checklist that they must complete. HR is responsible for the administrative matters, paperwork and initial onboarding of the employee for the first few days, but the responsibility for continuous learning and monitoring the success of the onboarding rests with

teams and supervisors. Teams are also responsible for instructing the use of tools and teaching work tasks. Some tasks also rely on employees learning them over time. There is also a societal perspective on IKEA's onboarding, with many IKEA employees at their first job. At IKEA, young employees learn how to be at working life. The annual turnover of IKEA staff is high and around one hundred new employees start up every year in Tampere. As IKEA consumes a lot of human resources and money in orientation processes, it may be necessary to streamline the processes. On the other hand, people who are being trained need to learn a great deal of information at one time and ongoing support could be useful.

The interviewees felt that the IKEA onboarding process is currently operating relatively well. However, the main problem for both interviewees was that the training of new employees is very time consuming, especially for other employees. The onboarding program covers a great deal of content, so it consumes huge amounts of resources. The number of person hours required for onboarding is so great that it even has an impact on the business. Especially at the very beginning, new employees need a lot of supported time to get the job started. There is a lot of familiarization to be done, and onboarding requires that another employee, during his or her working time, is guiding the new employee hand-in-hand with their tasks. Not all things can be taught in one day, but the instructors also have their own tasks that should be taken care of. Especially, there is often too little time to teach the most challenging tasks and rare situations. Indeed, IKEA employees felt that the onboarding could be even more systematic and planned, but that it would require much more time and human resources, which may not be available.

According to IKEA interviewees, the most important thing in inducing new employees is to ensure that all necessary information is taught. However, this is sometimes very challenging as there is not always a clear understanding of what each individual should learn. It is important that the onboarding is individual-oriented and can be done on the terms of the onboarding. The scenario where the onboarding is done too quickly, and the new employee gets a really large amount of information at a time and can't remember or understand everything is probably very common. Consideration should therefore be given as to how to ensure that the onboarding cycle will be such that the amount to be learned will be sufficient

at one time. Sometimes the challenge is also to have more than one instructor. In this case, the instructors may not know what others have said, resulting in overlaps or gaps.

Another challenge is the extent to which supervisors and teams have responsibility for onboarding tasks. This is reflected in the very varied quality in the onboarding that people receive. This also has the effect that HR often does not know at what stage each individual's onboarding is at the moment. Because supervisors are responsible for implementing best practices, they may also be reluctant to teach things that they do not consider important. HR loses contact with people quickly and continuous active support could be much more. However, more resources might not be available to provide ongoing support. Therefore, it would be very important to ensure that the flow of information between the learners, supervisors and HR works better in order to better know how well the onboarding is going.

Both IKEA interviewees felt that the problems with the onboarding were related to the people, the organization, and the information systems used. They all have a role to play and each brings their own challenges. People-based problems are mostly due to the fact that superiors' attitudes towards orientation vary and not everyone attaches the same importance to them. Also, people's memory for all things they are familiar with is limited, so it could be better supported. There are many systems to learn, and an organization-wide orientation program may not always work as well for everyone. Controlling the quality of the organization-wide orientation process is also challenging. Better information sharing could provide better support for HR in the process. Challenges are also posed by the fact that the trading industry is constantly changing and so is the work involved. It would also be important, for example, to keep up with digital developments.

## Possible applications of AR in IKEA's onboarding

IKEA representatives were introduced to the idea of using AR for orientation. They both knew what technology was about, so it was easy to start a conversation. Both had a very positive attitude towards the use of technology and a lot of ideas for further reflection emerged during the conversations.

The various application options discussed were varied. As an opportunity to take advantage of the lowest threshold, standard training with AR, such as safety training and area navigation tours, was discussed. This would introduce AR content as part of current orientation work. XR specialist considered this a relatively easy option. He thought that the content could be created quite easily. Transferring standard training to AR format could free up human resources, as no one would need to recycle new employees around the store. Another IKEA representative came up with an idea for weekly store walks that could teach you different things about the store. Navigation tours would apparently be relatively easy to scale using the same template to different stores, because although the stores are different, they consist of similar parts.

A slightly more advanced form of utilizing AR could be "extensive work environment by AR," where the app could tell new employees about their environment every time they move around the store. The app could show employees shelf locations, product information, and retrieve user information from other systems as well. For example, it could tell the user the details of a particular sofa by clicking on it and tell its stock balance. According to XR specialist, this could well be possible, especially since IKEA already has 3D models of its products, so it is possible to identify them with the software. According to XR specialist, however, in such a case, it would be very important to define very precisely what the user really needs. For example, it is not advisable to display all product information on the screen. Another IKEA interviewee pointed out that such technology could have applications for customers as well.

All at the highest level of discussion were all about the interactive onboarding program through AR. In such a program, the entire individual would be onboarded through a single application, which would be constantly aware of the progress of the subject. The app would advise a person on human contact in demanding situations with the right people. The application could have a personal virtual “HR person” who could also be asked questions by the new employee. The application would also provide HR with feedback on the success and the situation of the onboarding. An onboarding program would guide the new employee's first working days, tell them when it's time to go to the store, and give the employee the right amount of information at a time. Of course, this embodiment would require

a lot of resources because it should know a lot about the environment. Numerous interfaces to other systems would also be needed. However, XR specialist did not see any technical challenges in this either. In his opinion, the most important thing here would be to determine what information really should be put to the application.

However, IKEA's interviewees also saw challenges in utilizing AR. The development of new technology consumes resources that are always limited. In order to embark on such a large investment, it would have to come from the highest level of the organization. It is also important that the role of people in welcoming new employees is not diminished despite the use of technology. Social contact is very important in a new job. Also, the number of integrations and interfaces needed could be a challenge, as HR alone utilizes numerous systems, and some of them are different in different countries. Learning how to use a new application and integrating it into processes also takes time and requires change management. In a large organization, things and processes also change very slowly. Another interviewee also wondered whether it is appropriate from the customers' point of view that staff use their phones or AR glasses continuously at work. Another question was whether staring at accessories could cause security problems in the store. However, both interviewees believed if budget and change management were not their concerns, they would adopt the application immediately.

IKEA interviewees also found many benefits that could be gained from using AR. Applications that staff would use over their own phones were considered particularly useful and possible embodiments. IKEA has sophisticated standardized processes, so AR could be well suited to support them. The interviewees found it particularly useful to utilize AR in matters that concern all employees. For example, outsourcing safety training and in-store demonstrations to an AR solution was considered really beneficial, because that would release a lot of human resources. In this way, a large number of basics could be made into packages that are common to all. IKEA has long been planning a common electronic platform for onboarding, and AR could work well as part of this with more traditional learning platforms. AR could also reduce the impact and amount of human error and forgetfulness associated with information flow. Standardized digitized training could help ensure that the basics that everyone needs to know are sure to be

shared with everyone. Another interviewee also felt that IKEA people would probably be properly motivated to work with such technology. She also emphasized that IKEA is such a large organization that it can really influence technology development. IKEA has been striving to be digitalized in all its operations, so AR would sit in on that thinking as well. IKEA's interviewees highlighted the importance of carefully examining how much resource savings AR could actually make before investing.

XR specialist saw a lot of opportunities and links to AR's well-known benefits in supporting onboarding and in-store context. He also put forward the idea of introducing competitive training and gambling through AR. According to him, the most important thing when designing onboarding applications would be to identify the problem areas in the current processes that AR wants to support. You should find out what are the things that are often overlooked. Defining familiarization scenarios and defining the value you want from AR is important because not everything is worth trying. XR specialist also emphasized the importance of the benefits outweighing the resources needed for implementation. It is important to measure how quickly the investment would pay off. Will the implementation lead to better onboarding? Are there fewer mistakes in onboarding after implementation? It may not be enough to make things look great, but the benefits may have to be reflected in the business results.

Other issue he raised was the need for careful selection of equipment. Hololens-technology can provide the most comprehensive experience, but it costs a lot. So, is it necessary to buy expensive glasses or do the same benefits come with the workers' own phones? XR specialist found it technically easy to implement positioning and environmental identification, and he said that these things can be done with very different levels of accuracy. Devices can only bring content based on their location, but they can also be taught to recognize elements in their environment and to understand how far products are from the position of the phone. XR specialist also emphasized the importance of defining what and how much information users want to bring. It is reported that there is a common problem that AR environments are overused. According to him, AR has two functions: facilitat-

ing spatial observation (eg by means of arrows) and, on the other hand, introducing abstract content into the environment. They need to be in balance, and not so much information that the environment becomes confusing instead of clear.

All in all, the interviews can be said to have gone well. Case-related interviews provided certainty that AR could really be used in onboarding. There are challenges, of course, and it is important to determine what the benefits are, but the idea has potential.

## FUTURE PROSPECTS OF AR IN ONBOARDING

This chapter summarizes the possible solutions for the IKEA's case study for the use of AR in onboarding. After that, the prospects of using AR in onboarding are considered. Chapter 4 explored several possible solutions, the best of which are summarized in Table 1. The solutions are presented and substantiated with quotes from the interviews conducted. In the third column is always a quote first from IKEA and then from the XR specialist.

**Table 1.** Possible solutions for Case IKEA (Ikea employee 1 & Ikea employee 2, personal communication, February 2020; XR specialist, personal communication, February 13, 2020)

| Solution | Description | Interview-based justification |
|---|---|---|
| Standard training packages with AR (eg. Safety training, area navigation) | Implementation of simple standardized training materials through AR applications. AR is part of the other onboarding process. | "Transferring standard training to the application would free up a lot of human resources and, also, would fit well into existing processes."<br>"Content easy to implement and with very small adjustments to move from one store to another." |
| Extensive work environment by AR | Store guidance and product introduction for new | "The solution could greatly facilitate the learning of new employees but could also be |

| | | |
|---|---|---|
| | employees. An AR application knows the whole store and can tell the employee where to find specific products. Helps user to navigate and connects information to the environment, such as product and inventory information. | beneficial to old workers and perhaps even customers."<br>"Navigation is easy to build, especially on the stock side. There are many ways to clarify and describe the environment. Product showrooms are more challenging." |
| Interactive onboarding program through AR | Transferring the entire orientation program for AR solution. The interactive application guides the learners throughout the process, tracks their development and when necessary, guides them to the right people. | "It could be useful and also fun for employees and save on human resources. Could enable more ongoing support. Implementation would probably be a very long project because the organization is so big. The available resources are also a question."<br>"Today's AR technology is capable of really complex things and can recognize many things about its environment. However, the more AR is required, the more expensive the implementation will be." |

Last, we look at the prospects that Ikea's AR solutions would face. First, we discuss the technical opportunities and challenges and after that the prospects from the human-orientated point of view.

## Technology-oriented factors

After conducting the interviews, we identified two different ways to approach the solutions from technical point of view. The simpler solution is a see-through mobile app which utilizes AR elements to show location instructions in a warehouse environment. With the help of the app, a new warehouse worker can find products faster without memorizing the entire layout of the building. This approach has a several advantages: it doesn't require head-mounted displays or other AR-specific devices which reduces costs and the need for additional training. Secondly, the solution could be later developed for customer use as well (XR specialist, personal communication, February 13, 2020). However, the added value of this AR solution is minor.

A more robust solution would be a customized training course (or several different courses) made for HoloLens or similar "smart glass" device. This approach requires more resources by a large margin but offers several options for different onboarding phases such as safety course, basic product information course, "nice-to-know" product trivia course after the basic course etc. In addition to having the software and devices, this solution also requires an experienced employee who designs the courses. In addition to possible onboarding improvements, using "cool" hardware could motivate employees and improve brand value as customers can see new technology in action. (XR specialist, personal communication, February 13, 2020) However, the initial investment is significant in this approach.

One major opportunity with especially in the second choice is that the re-development of the app is possible (XR specialist, personal communication, February 13, 2020). Because Ikea has several stores and functions in those, it might be wise to expand the use of the app to different tasks, not just the onboarding process. The specification of the app could focus on to ease specific tasks for example in specific departments such as bathroom or living room and the customer service in those. The specification could also focus on customers and therefore ease all customer servicers work. For example, store could have shared head-mounted AR displays in which the customer could find the products they need or find the fastest way to cashier.

Other opportunity is gamification and competitions. Alpkin and Temmen (2019) states that when it comes to learning, feedback is crucial part of that. Some people find rewards being the goal of learning, which are usually verbal ones from supervisors. (Alptekin & Temmen, 2019) With AR technology, the learning process can have more personalized rewards. For example, if a new employee reaches a certain level in her or his learning process with good enough points, reward could be some extra points in next task or concrete rewards as free cup of coffee or extra 5mins to next coffee break. Gamification of the app could be a good motivator for the employee to learn and iterate tasks well.

The biggest challenge of the product is the modification. When it comes to any software projects, the key element is the agreement between customer and provider (Ebert 2002). Ikea needs to know exactly what it wants for the product to do and what it can't do. Provider needs to understand the needs and therefore produce the needed product with needed modifications. In the modifying process it's also crucial to pay attention to the common challenges that AR technologies usually have. These are for example accuracy, parallax error, latency and calibration (Azuma et al. 2011). When it comes to onboarding, especially accuracy is the key element.

Other challenge that might occur are other technologies or patterns that might eliminate the existing onboarding problems (Kalliokulju & Palviainen, 2020). The main reason for creating and implementing this AR technology to Ikea's onboarding process is to decrease problems and resource loss and humanly mistakes that happen. If a new technology that fits better to these onboarding problems occur, there isn't need for AR.

## Human-orientated factors

Developing an application based on AR technology to help new employees get started can help them save resources. As mentioned earlier, at present, orientation takes a lot of working time from those responsible. This working time is away from tasks requiring expertise. (Kjelin & Kuusisto 2003) If most of the onboarding could be organized through the application, it would free up the time of supervisors and other onboarding personnel for other tasks. This is perhaps the biggest and most important benefit opportunity that this solution could bring.

Another benefit that could be achieved through the solution is that it would be easier for the people being trained to return to what they were taught, without the need to disturb the person being responsible of their onboarding. It could also be easier for the person to be onboarded to the process at their own pace, so that they can absorb the right amount of information at a time. In this way, utilizing the AR application would make it easy to make onboarding process more appropriate for each individual. This was also considered a particularly good thing by IKEA.

Using the new technology requires some additional work equipment. The interviews we conducted revealed that the target organization is currently not allowed to use its own smartphone during working hours. When implementing AR in an organization, there is a need to review current policies and guidelines for work. The organization should consider whether they want to invest in equipment that employees can use for onboarding, or whether they are allowed to download the onboarding application on their own smart device, giving them the right to use it during working hours. When considering what kind of device to use the application, the nature of the work should be considered. For example, would it be easier and safer to use end-to-end glasses in warehouse work than to use a handheld smart device, as this would free up both hands for work. (Joshi 2019) Whatever is done in an organization, decisions must consider the demands of the job. Occupational safety should not be compromised, even when using AR technology.

One challenge that also the AR expert interviewed pointed out is that using AR can cause cognitive overload in humans (XR specialist, personal communication, February 13, 2020). The human brain is unable to detect and process more than a certain amount of information at a time. It is not good for AR to bring so much information to a person that he/she is no longer able to understand his/her environment, as it can reduce a person's ability to act and thus lead to, for example, dangerous situations. (Razavi 2008) Many people may also experience an ever-increasing amount of data and information overwhelming, and it may not make it any easier for them to suddenly be able to see much more than the real world in their working environment. The fact that you really must spend a lot of time working your AR glasses off during your workdays could make many feel anxious or overwhelmed, and cause headaches, for example.

Finally, it is still important to understand critically whether AR will ultimately provide enough value to the onboarding processes to be profitable. The benefits must be large enough to be worth the effort and resources. This was also highlighted in the interviews, as AR projects are expensive and need to be confident that the performance is sufficiently improved in relation to the resources used. Predicting this is of course difficult, if not impossible, but if such a project were to be undertaken, it would be necessary to continually review and test whether the solution would truly help the work of the educators and the people being trained. If the people and businesses using the application hardly feel that it will bring any additional benefits to their operations, the question of why they should invest should quickly come to mind.

## CONCLUSION

The research identified three main challenges on the onboarding of new employees. The first challenge was the lack of time and other resources. Families are often supervisors or HR people who are usually really employed. The onboarding takes time from their other tasks, which usually require a high level of expertise. Another challenge is the inadequate allocation of responsibilities for onboarding. This can lead to unnecessary duplication or lack of onboarding. The third challenge was the needs of new employees. Familiarization experts do not understand the needs of the new employee at a sufficiently deep level, so that the essentials are easily missed. In the worst-case scenario, for example, occupational safety can be endangered.

The research identified how augmented reality could response to these main challenges. Based on literature, augmented reality was found to ease the human-based problems such as supervisors lack of time and forgetting to teach everything decreases. Augmented reality also makes the quality of the onboarding process more even. There are currently several AR training solutions on the market, but none of them are specifically focused on the onboarding of new employees.

The use case of this research was Ikea and the Ikea’s employee’s interviews also proved that there can be potential use-cases for AR in new employee onboarding. The interviews found many ways to utilize AR in a variety of onboarding tasks,

and IKEA also found that they could alleviate the resource problems they experienced. In the opinion of the AR expert, the technical implementation of such applications would also be possible. The interviews also identified the challenges and benefits of using AR. The biggest challenges are related to the resources needed for development and how much support it would require from company management. The biggest benefits are in making the onboarding more personal and in saving the work time of the supervisors.

Based on the interviews, two different technical solutions for IKEA are proposed: a hand-held see-trough AR guide for product location instructions or a more robust head-mounted display with customized training courses. The latter needs more resources, but also provides more added value and could potentially free up more time from the supervisors. In the end, IKEA must calculate whether these AR solutions save enough time or provide other additional bonuses to overcome the costs and the effort needed for AR adoption.

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# APPENDIX A: IKEA INTERVIEWS

1. Title/position
2. How long have you been working at IKEA?
3. What kind of onboarding-related responsibilities do you have?
4. How do you see the onboarding process at Ikea?
4.1. Are there large differences between different tasks?
4.2. Do you feel that onboarding is harder in some specific tasks? What and why?
5. What is important in onboarding in your opinion?
6. What kind of problems exist in onboarding in your opinion?
6.1. Is there a spesific area in onboarding that is especially challenging?
6.2. Do you feel that the problems are based mostly on people, systems or the organization as a whole?
7. What kind of resources onboarding needs and how much?
8. How could onboarding be improved?
8.1. Can you personally affect that or are instructions organizational?
8.2. What are the biggest areas for improvement?
9. Have you used any AR technologies or applications?
9.1. Do you feel that AR is useful?
9.1.1. If not, do you think that you could utilize AR in our personal life?
10. Do you feel that AR would be applied into your work environment?
10.1. If not, why?
11. Do you feel that AR could be utilized in onboarding (e.g. mobile applications or AR glasses)?
11.1. If yes, how?
11.2. If not, why?
12. Do you feel that AR could solve some onboarding-related problems?
13. Do you feel that some other technology could fit onboarding better?
13.1. If yes, what and why?
14. What kind of issues could be especially difficult in AR adoption?
15. If you didn’t have to take budget, change management or technical implementation into account, would you use AR in onboarding?

# APPENDIX B: XR SPECIALIST INTERVIEW

1. What do you think of our idea of using augmented reality on Ikea's onboarding process?
2. Can you think of any limitations and challenges that it might have?
3. What kind of similar products already exists or are invented?
3.1. How about products that are specified to onboarding?
4. Do you have other development ideas for us or some tips that we might need?
5. To summarize our conversation, what are the top five requirements for this kind of a product that we have talked about?

# AI AND TRANSHUMANISM: WHAT ABOUT ETHICS ?

Group Assignment
Emerging Technology Adoption and Use
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# ABSTRACT

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This study aims to find out a phenomenon and present findings and solve the problem related to that phenomenon. The problem for this study is how artificial intelligence and transhumanism can work together as ethic issues are becoming more important into our lives.

This study focuses on the artificial intelligence related to the transhumanism. In the context of technological breakthroughs and the will of scientific to improve human condition, this topic is more and a more burning issue in our society. For this assignment, the theory about artificial intelligence and transhumanism is gathered and analyzed with an ethical context. Our assignment will discuss the benefits and drawbacks and the limitations related to ethics. Some solutions are presented to try to improve these uses in future cases. Our work also wants to present the main issues of this topic related to ethics and think about possible scenarios related to the future.

## INTRODUCTION

Technological advances and the desire of improving human condition leads to what we know under the term of transhumanism. Artificial intelligence applied to transhumanism allowed to scientists to modify, improve the human condition. According to James Scott, the co-founder of Institute for critical infrastructure technology “Man is to technology what the bee is to the flower. It’s man’s intervention that allows technology to expand and evolve itself and in return, technology offers man convenience, wealth and the lessening burden of physical labor via its automated systems.” Indeed, we’re in an area in which technologies are linked to humanity. However, improvements related to humankind arises a lot of issues especially with ethics. Indeed, is human condition can be modified without any limits ? Are augmented humans still human ? The aim of this research is to investigate and discover what it’s really possible actually and what will be the possible scenarios. Focusing on some theories to understand the different point of views for this issue.

Firstly, we analyzed the artificial technology applied to transhumanism and the outcomes related to it. Then we looked at the bright and seamy side of it. This led us to look for what’s happening already in today’s society and try to understand the issues related to ethics. That is why we focused on the existing theories concerning this topic.

Our plan is the following: What is Artificial Intelligence, Transhumanism and how are they connected. Then we will discuss ethics in AI and transhumanism, what theories exist, and what are the biases. Finally, we will tackle the future of AI and transhumanism, and if it means the end of humanity. We will often resent the worst-case scenario.

# ARTIFICIAL INTELLIGENCE AND TRANSHUMANISM

## What is Artificial Intelligence ?

According to the analysis of J.B Copland's (2020), AI is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from experiences.

AI it is a lot of things/factors. It can be defined as an unstructured data, a natural language processing. It can also be a knowledge representation, an automated reasoning, a computer vision or a machine learning (machine can learn things from data that was gathered). AI could also be seen as robotics, as a mean to interact with what's beyond the machine in a real environment.

There are different aspects of AI. One of them is known as data lakes, a scalable and massive storage of raw data. To use the lake of data, you need physical application to keep all this data, and store it. We need a physical way to store it, but we have to be able to use it at the same time in any country of the world. A second aspect of AI is chatbot, a small application that companies often use nowadays to keep in touch with their customers without having a real person behind their screen. Today it is getting easier to create one and companies like IBM offers to create a first assistant powered chatbot. The last aspect of AI is the predictive customer lifetime value modeling, a prediction used by online retailer to understand customer's consumption habits and try to work with it. Some companies had prevented some particular individuals to buy in their shop because they were returning a lot of stuff and it was not good for the company's business. This kind of data is giving a lot of information to the companies, that claim to use this system in order to be more sustainable.

Looking at figure 1 of the Gartner hype cycle from 2019, we can see that AI is expected to have major impact on society in the next 2-5 years. (Gartner 2019), so the possibilities for the use of AI should be considered seriously. Indeed, the figure 1 also show the use of AI in different aspects e.g. Augmented Intelligence, Explainable AI, Edge AI, AI PaaS etc. Bostrom et al. (2009) points out that given

the enormity of the consequences of artificial intelligence, it would make sense to give it some serious consideration.

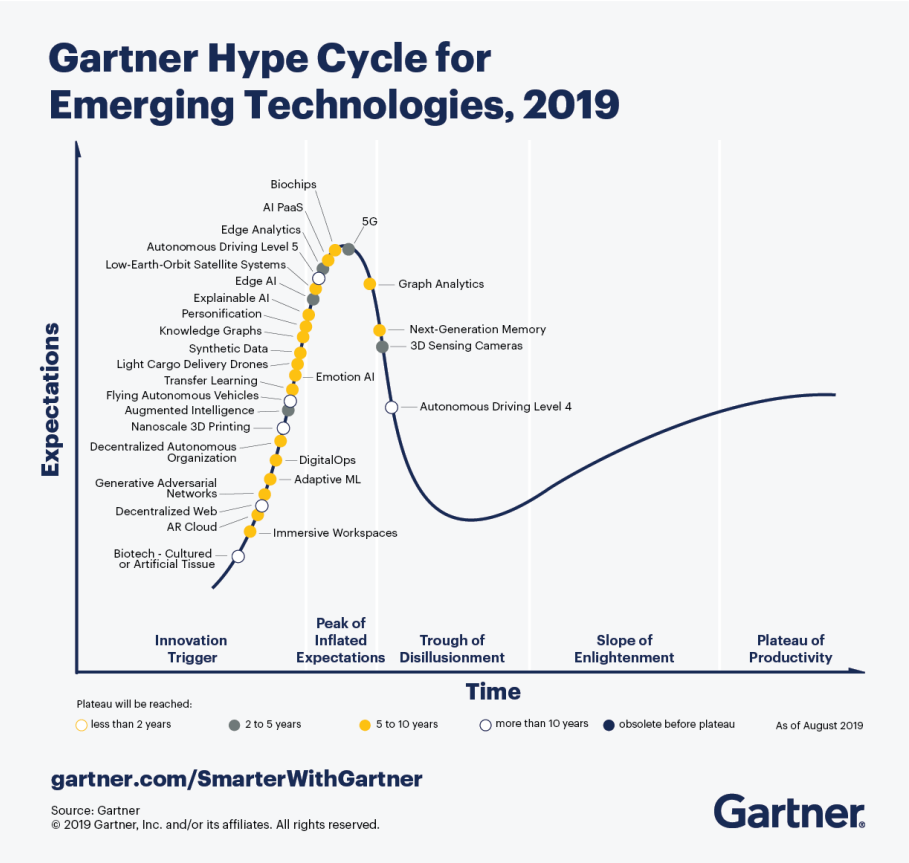


*Figure 1: Gartner Hype Cycle 2019 (Gartner 2019)*

## What is Transhumanism

Nick Bostrom worked on transhumanism values (2005) and defines it as a gradually developed movement that promotes the interdisciplinary approach to understand and evaluate the opportunities for enhancing the human condition and the human organism by the advancement of technology.

The belief or theory that the human race can evolve beyond its current physical and mental limitations, especially by means of science and technology. Transhumanism is a philosophical and intellectual movement advocating the use of science and technology to develop the physical and mental capacities of human beings. Transhumanism considers certain aspects of the human condition such

as disability, suffering, illness, aging or suffered death as unnecessary and undesirable. In this perspective, transhumanist thinkers rely on biotechnology and other emerging techniques.

There are four pillars that are represented transhumanism called NBIC: *nanotechnologies, biotechnology, information technology and cognitive sciences.*

*Nanotechnologies* are the technologies that allow us to manipulate matter on the scale of a billionth of a meter, or even of the atom. In order to always improve the lifespan of man, nanotechnologies are implemented to find new techniques to detect different human diseases, regenerate the body and interfaces with the human spirit. Nanotechnology could in the short-term make nanoparticles effective for targeted treatment of certain cancers, In the longer term, nanotechnology could make nano-robots allowing us to self-repair

Next, *biotechnology* brings together many techniques including, among others, genetics and regenerative cell biology, it represents the alliance between life science and technologies from various other disciplines such as physics, chemistry, computer science. Thanks to bio technologies it will be possible to correlate the appearance of many diseases with certain specific genes by using massive computer processing on numerous genomes (big genetic data in a way) and they will allow everyone to know their predispositions to different diseases in order to treat them preventively. It will also allow doctors to tailor treatment individually

Then *Information technology*, which already existed for many years, is constantly improving and could lead to a new processing of information. It will also be used for research in other fields. In the more distant future, the use of information technology could lead to the emergence of artificial intelligence as "intelligent as man" and capable of reprogramming itself.

Finally, *cognitive sciences* also known as brain sciences include studies on the brain, neurosciences, neural implants, psychology. In the short and medium term, brain studies could already help overcome neurodegenerative diseases. In the medium or long-term, cognitive science could allow us to maintain or even increase our cognitive capacities over time by stimulating neuronal growth, by medication (with the development of new generation nootropics, for example) or by interfacing our brain with electronic implants.

The transhumanism movement is not a myth. However, it is already very present, especially in the sports field: ultra-advanced prostheses for the disabled, for example (Bostrom, 2014). For the moment the applications that we have seen are promising and remain for a medical purpose (to help disabled people) but in the coming years, we can be practically sure to see appear all kinds of body modifications intended to improve the being human.

## Utilization of AI in Transhumanism

Today, we are able to use AI in many fields and some of them have to do with ethics and the human body. Here are listed some example of use of AI.

Our first example is an intuitive prothesis or bionic hand, largely used in the medical surgery. New generation prostheses linked to the nervous system and powered by several motors capable of reproducing all the movements of the original limb. Thanks to artificial intelligence, it is now possible to carry out almost all movements without the patient having to think about how to move his artificial arm. This task would then be carried out by the prosthesis itself.

A bionic hand developed by researchers at the University of Newcastle (UK) is able to choose the best way to grab an object. For this, the prosthesis is equipped with a digital camera and a minicomputer allowing it to identify the object to be grabbed. Artificial intelligence will analyze the characteristics of the signals transmitted by the muscles and thus control the pressure that each finger must exert. To calibrate and adapt the prosthesis to a patient, the patient repeats each gesture several times in order to create a comparison database.

A second example of the use of AI in transhumanism is the implanted chips in the human body. In addition to "repairing" or "augmenting" the human being, numerous experiments have been carried out with the aim of connecting it to machines, directly by thought, or more concretely, by the electrical signals sent by the brain, since all our actions are controlled by our brain. The director of Tesla Motors and SpaceX, Elon Musk, has created a new company called Neurallink,

whose mission is to develop implantable brain-machine interfaces (BMIs), to connect our neurons to artificial intelligence and merge people with artificial intelligence. Once implanted, if you believe Elon Musk, the chip will establish a wireless connection with the devices. "It's like a Bluetooth connection to your phone." The objective sought is to improve our memory or be able to interact directly with electronic devices in the future without going through traditional interfaces. Musk also mentioned the potential for the company's neural implants to improve people's life with brain damage and other brain disabilities.

A last example of use of AI is with Cyborgs. We call "cyborg" any living being - generally human - which would have been "increased" by mechanical additions within its body. Are we already "cyborgs"? If a cyborg is a man whose capabilities have been increased by technological progress, then a good part of humanity can be defined as such. According to some researchers, we have already entered the era of cyborgs, with the proliferation of electronic devices in our daily lives, which invade our lives until they become essential. Televisions, telephones, satellites, Internet: all these tools allow us to interact with the whole world and therefore to increase the scope of our actions and our ideas. This explanation is for most individuals too "romanticized", because progress is the property of man and the technological tools he uses cannot alter his primary condition. We will thus speak rather of an "augmented" man.

A more down-to-earth definition of the cyborg would therefore be the modification of a body, even a human one to attribute new physical or mental possibilities to it, and therefore a fusion between man and machine, via transplants or the implantation of chips within of the organism. Research is numerous, and affects several sectors: medicine, robotics, cybernetics, nanotechnology, biotechnology, cognitive sciences, etc. Mechanical grafts have been around for a long time, for example with pacemakers, the same for artificial limbs, but that does not mean giving different beings. We could even refer to glasses or hearing systems as cases of human technical improvements. Rather than an "increased" man, we are talking here more of a "repaired" man. It is obvious that we are not yet in the cyborg stage as we have been able to define it, but there is much research which goes in this direction.

## Advantages and drawbacks

Highlighted by Bostrom and al. (2014), some challenges of machine ethics are much like many other challenges with designing machines. It involves new programming challenges, but no new ethical challenges.

## Benefits

The transhumanist movement is increasingly integrated into society or can see it through these different points: The first argument could be that transhumanism aims to improve living conditions. Indeed, there is a medical advancement with for example prostheses for the legs, hands, arms or even artificial hearts, and implants. These new technologies improve the life of humans and allow some to find a normal life. From this point of view, transhumanism is widely integrated by society. In addition, transhumanism would improve living conditions if, thanks to biotechnology and other emerging techniques, thinkers manage to find solutions concerning life expectancy, disabilities (mental and physical), poverty and disease.

The second argument suggests that transhumanism pushes researchers to make real discoveries and advancements for humans. Indeed, thinkers are constantly looking for ways to improve the technologies already in place and find new concepts.

The third argument is the fact that transhumanism has a positive impact in the cultural field because it has allowed the creation of science fiction films and series staging these advancements like Matrix, Terminator, Ghost in the shell or more recently Her.

The fourth one highlights that transhumanism also has a positive aspect on the economy since it pushed certain firms to invest in Transhumanism. Indeed, these companies will finance many technologies in order to obtain results. For example, Google funds research centers. (Google is a leader in transhumanism with its investments in robotics). This spending in this new movement benefits the economy and is a positive impact of transhumanism.

In addition, the fifth one is that transhumanism has created alliances. Several companies have joined forces to verify compliance with certain aspects: legal, for example. These alliances allow transhumanism respectful of society and its populations.

The sixth argument mentions that transhumanism tries to delay innovations in Artificial Intelligence and tries to keep a society where human beings are not robots. This movement tries to ensure that humans are not overtaken by machines while having better living conditions.

Finally, the last argument could be that transhumanism forces societies to think about themselves and this is a positive point. In fact, transhumanism forces people to question their beliefs, their values and what they want for their future. Societies can decide to have faith in transhumanism and its advances. In addition, this movement is forcing societies to accept change and adapt to new technologies and the resulting changes.

## Disadvantages / Issues

Transhumanism is a still growing movement whose risks and abuses are not studied. Certain populations remain very suspicious regarding transhumanism, and negative aspects are developing more and more around this movement.

Among these risks and its excesses, we find: *Risk of extreme inequalities* (in terms of longevity, intelligence, power ...) if these improvements only benefit a small elite group. This can thus generate inequalities between individuals who will be divided into new social classes.

Then, we find the *Risk of dependence* on the private sector. For example, if an arm prosthesis (or a treatment allowing a person to live beyond 150 years) belongs to a business cartel which can fix the price or abruptly withdraw them from the market. The virtual monopoly of players like Google makes this possible.

More generally, it exists the *risk of commodification* of "everything" (human body, procreation, lifespan), extension of copyright to all aspects of life, etc. Next could be the *Risk of disasters* threatening the survival of humanity: accidental creation of an overpowered virus,  or out of control artificial intelligence.

Also, the higher *risk of controversial practices* (GMOs, cloning, cryogenics, etc) such as modification of genes / DNA. We can give an example: the creation of the first artificial cell, created by Craig Venter, bio technologist and American businessman, in 2010. From there, we know that the genetic program works like software. New technologies have been developed to better control procreation: prenatal diagnosis (PND) and pre-implantation diagnosis (PGD). The goal: to know if the fetus is malformed. It is primarily intended for parents who wish to avoid the transmission of hereditary pathologies. If the embryo is not healthy, it is not re-implanted in the mother, preventing the latter from having an abortion. This technique leads to drifts: in the United States and in the United Kingdom, parents make conceive "handicapped babies", so that they have the same physical handicap as their parents.

Finally, the last one is the *risk of transhumanist excesses and eugenics*, these extreme methods of transhumanism are controversial because transhumanism, at its beginnings, aimed to "reduce inequalities, improve living conditions, fight against malnutrition, disease, handicap and old age. Today, these new movements want to bring about a human over-evolution and push the limits of science. In the transhumanist statement, "Everyone has the right to choose whether to improve their abilities, depending on their own aspirations and the control of their body and mind." However, if people decide to become supermen for example, and others do not, this will lead to major differences and submissions.

## WHAT ABOUT ETHICS?

Nick Bostrom and Eliezer Yudkowsky worked on the ethic of artificial intelligence (2014) and consider that the possibility of creating thinking machines raises a host of ethical issues. It would relate to both ensuring that machines can’t hurt humans, but also to the moral status of machines.

Ethics is the science of morals and mores. It is a philosophical discipline which reflects on the ends, on the values of existence, on the conditions of a happy life, on the concept of "good" or on questions of morals or morals. Ethics can also be defined as a reflection on the behaviors to adapt to make the world humanly habitable. In this, ethics is a search for the ideal of society and the conduct of existence.

## What problems transhumanism raises ?

Over the last few years the field of AI ethics has become a large activity. Indeed, many warnings are coming from a variety of experts (from Oxford University's Nick Bostrom), and also from public figures like Elon Musk of Stephen Hawking. Some dream to create a set of principles to guide AI researches and help them negotiate the "maze of human morality and ethics".

The field of AI ethics would be broken in two areas : one concerning the ethics guiding humans who develop AIS, and the other one about machine ethics and guiding the moral behavior of the AI robots.

The science fictional write Asimov explored the limits of those laws through numerous writings and found three mains laws. To highlight the flaws in the ethical principles of the three laws, an organization called the Singularity Institute for Artificial Intelligence, headed up by the American AI researcher Eliezer Yudkowsky, started an online project called *Three Laws Unsafe.*

Yudkowsky, an early theorist of the dangers of super-intelligent AI (2014), argued that such principles would be hopelessly simplistic if AI ever developed to the stage depicted in Asimov's fictions. Despite the recognition of the drawbacks of those laws, many organizations still want to develop principle-based systems of AI ethics containing ethical principles or guideline for AI.

Bostrom and al (2014), argue that when AI algorithms take on cognitive work with social dimensions, the AI algorithm also inherits the social requirements. Transparency is not the only desirable feature of AI: it is also important that AI algorithms taking over social functions be *predictable to those they govern*. AI algorithms need to be responsible, transparent, auditable, incorruptible: these are criteria to be considered to humans performing social functions.

Another source of controversy regarding the transhumanist project is the issue of social justice. Many fears that the possibility of radically obtaining human capacities will widen a gap between those who use the use of these new technologies, and those who will not want to do so, or will not be able, for lack of means, thus amplifying the socioeconomic inequalities concerned. According to some, this danger justifies that one prohibits, in the name of equal opportunities, the access to such interventions, a little to the way in which doping is banished from competitive sports.

## Biases and theories

## Technological singularity

Ray Kurzweil prophecies a dramatic future event—not in the distant future, but rather just around the corner, 2045 to be exact. This will be a threshold event, an event known in his field as the “Singularity.” which will influence deeply human life that it will be irreversibly transformed. What follows this, is the observation that human intelligence will leap from human bodies to machines, making high-tech machines more human than we are.

Technological singularity (or simply singularity) is the hypothesis according to which the invention of artificial intelligence would trigger a runaway of technological growth which would induce unpredictable changes on human society.

The technological growth will become uncontrollable and irreversible, resulting in unforeseeable changes to human civilization.

Beyond this point, progress would only be the work of artificial intelligence, or "supra intelligence" which would self-improve, new generations more and more intelligent appearing more and more quickly, creating an "explosion of intelligence” and finally a powerful super intelligence which would qualitatively far exceed human intelligence.

The risk would be that humanity would lose control of its destiny. The science fiction author Vernor Vinge is even convinced, in his essay *the advent of technological singularity* (1993), that singularity would mean the end of the human era, the new super intelligence continuing to improve and evolve technologically at a speed incomprehensible to humans.

## Basilic de Roko's Theory

In 2010 a certain Roko posted on Lesswrongn (is a community blog and forum focused on discussion of cognitive biases, philosophy, psychology, economics and IA), a theory based on artificial intelligence and especially its ultimate evolution, the Singularity. A singularity is an artificial intelligence which would not only exceed the human brain but could reach up to 1 billion brains by 2050. It would be more powerful, faster, and from this level would also arrive at "self -improve "

A so-called "Friendly" super-AI would therefore see the light of day in the future. The purpose of this super AI would simply to work for the good of humanity. No more wars, diseases or injustices, it could potentially save every human being from all inequalities. Moreover, there all those who will go against this AI should be considered by it as harmful to the good of humanity. Super intelligence can therefore, because of this premise, punish individuals who oppose its mission. If such an AI is ever created, it will punish everyone who waited for its future invention and did nothing to make it happen sooner.

## Consequences and potential impacts

The Technological Singularity would of course be useful to the human being who built it, he would use it for various and numerous tasks of daily life. It could react directly according to the facts, without an external element coming to activate it. Man would then no longer have to worry about anything and would let different singularities, useful in a very specific area, act alone.

This would allow humans to increase their capacities to create more efficient machines by subcontracting the task to other machines. Which would accelerate

technological growth. Vinge (American science fiction writer) writes that superhuman intelligences (1993), created by humans with enhanced cybernetic abilities or by other less developed artificial intelligences, would be able to improve their own abilities more effectively than the human minds that designed them. Thus, an increasingly rapid spiral of progress would lead to very significant technological progress in a short period of time.

Despite the progress and the benefits, it could bring to humans, there will always be negative consequences for technological progress. Man could quickly be overwhelmed by his own creations and therefore would be useless in the creation process.

Unfortunately, by increasing the capacities of technologies to do well, we run the risk of allowing new means to do harm, to develop. For example, if nano robots manage to repair blood vessels, nothing prevents them to destroy them or even to implant themselves in the organism, thus being able to control parts of our body or even influence them. Similarly, robots usually intended to perform surgical operations independently of humans, could very well be diverted into weapons of war. Knowing what humanity has been capable of in the past, do such abuses seem completely improbable? If there were computers so sophisticated that they would be able to make even more powerful computers, this new generation of computers would develop and evolve so quickly, on their own, that engineers would quickly lag behind them for centuries. And from there, all control would become impossible. The question will therefore be whether humanity will accept to change speed, which could consequently redefine the concept of humanity, or if it will prefer to keep its current rate of evolution. But the advent of the singularity may be so sudden that no one can react. The awareness with a reaction time and observation on a human scale, then the political and legislative reaction, would be too slow compared to the possibilities of rapid development in the fields of genetics, robotics, artificial intelligence and nanotechnologies.

As robotics and artificial intelligence develop, and become almost independent, some fear that even many skilled jobs will be threatened.

If the Singularity cannot be prevented or restricted, no one knows how bad the post-human era will be. The physical extinction of the human race is a possibility,

as is the obligation for men to stop all electronic machines (even if this is more in the realm of science fiction).

## Biases in AI system that can be found

AI has become really inherent in facial and voice recognition systems. However, some of these systems have a real impact on people and business implications. They are vulnerable to biases and errors introduced by human makers. Also, the data that is used to train the AI systems can have biases. AI systems are able to detect gender for example, but those developed by Microsoft, IBM and Face++ have some difficulties to detect the gender of darker skins more accurately. Sometimes AI cannot be fair. Bias can creep into algorithms in a lot of ways. Friedman and Nissenbaum, in their essay *Bias in Computer Systems* (1996), identify three categories of bias in computer systems: existing bias, technical bias, and emergent bias. In a highly influential branch of AI known as "natural language processing," problems can arise from the "text corpus"—the source material the algorithm uses to learn about the relationships between different words.

Max More, a British philosopher and leader of the extropian movement claims that transhumanism is the “continuation and acceleration of the evolution of intelligent life beyond its currently human form and human limitations by means of science and technology, guided by life-promoting principles and values” (*Transhumanism: towards a futurist philosophy,* 1990). This very definition, however, is a paradox since the ethos of this movement is to promote life through that which is not life, even by removing pieces of life, to create something billed as meta-life. Indeed, it is clear that transhumanism banks on its own contradiction: that life is deficient as is yet can be bettered by prolonging life even to the detriment of life.

# DISCUSSION

## End of humankind

There is the arrival of new terms such as posthuman, transhuman or the overhuman of Nietzche. Transhuman, according to Bostrom (2004) would be someone who is an evolution transition to the coming era of posthumanity. That's why transhumans will still remain in the human species but some aspects will change. They will be the step for further evolution of species. The new species we can mention is the posthumans. Indeed, human beings and transhumans still will have the ability to reproduce themselves with each other but that posthumans won't be able to do it, at least not in the natural way. However, the concept of Bostrom concerning posthumans is quite different from the one of Esfandiary.

For Bostrom, posthumans would be able to achieve greatest things since they possess capacities and qualities augmented by technology. However, Bostrom believes that they will be able to develop into a being. Human, thanks to technology can be transformed into posthumans. Consequently, posthumans instead of being a different kind of species is a more particular group of human beings that have an improvement in all the human capacities (physiological, emotional and intellectual aspects).

## A possible evolution in future years

AI could give us two distinctive ways of viewing the future that stands in front of us. Many questions could be asked right now : will robots become self-aware ? In April 2018, Smithsonian magazine chose to present five scenarios that could happen if the future was dominated by AI.

One possible scenario could be that human get superhuman rights. What if AI "robots" could get some rights like going in front of the supreme court with a lawyer and claiming that they are alive and conscious. If this happens, AI robots would be able to have an identity, have some money and control it, and have emotions and thoughts. They wouldn't be machines with more intelligence than human anymore, but real part of the civilization.

A second possible scenario would be that human could live longer and prospered. The article suggests that during one life, we could live different lives. AI would help the human body to stay healthy and in good conditions during all those lives and some tools like sensors would always test our body in search for diseases, malfunctions or early signs of cancers to prevent them. AI would then be a medical assistant forever, while monitoring your immune system and telling the doctors what's happening inside your body. By 2065, AI could have revolutionized the modification of our genome. Scientists could be able to modify the human DNA, correct the genes according to our desire. These genes mutation could create new athletes or be whatever they want.

One last case scenario could be about AI helping government to run a country. Countries that would adopt AI assistant would be thriving. In some countries, AI "civil-rights" drones would be flying over the city to protect the inhabitants in case of danger. AI would advise the leaders about the economy, finance and social aspect of the country. However, in totalitarian countries like North Korea, this would highlight the dark aspects of AI : the government would know everything about each citizen, and there will be no privacy anymore. Also, this could be dangerous if the government try to use AI in the military field and start training the robots against a certain group of people, this could have a major impact.

## CONCLUSION

To conclude AI permits the development of augmented humans through the movement of transhumanism. Indeed, the various technologies included in AI combined with the will of improving human conditions enable the possibility to see the arrival of cyborgs for instance. Even, if transhumanism contains a lot of advantages there is still some drawbacks. Plus, it arises some issues concerning the ethics divided in two areas : the one guiding human who develop AIS, and the other one about machine ethics and guiding the moral behavior of the AI robots.

There is also the development of several theories, namely the technological singularity or the Basilic de Roko's theories. This leads to different effects and not only good ones : How to really control this technology? If we are overpassed by robots, and they can repair themselves what will be able to do?

Several questions are still without answers. In the same way the humanity will change. The arrival of posthumans, next step after the transhumans, shows how we are still at the beginning of the change operated by technology and that we don't know yet exactly in which way it will be manifested. Even if it could be just the life expectancy of humans being extended for the next years, this arises some new ethical issues. Indeed, who will benefit from these advances? Is everyone will be able to benefit from it? This could reinforce the inequalities between rich and poor people. New challenges will certainly appear if the transhumanist technologies succeed to prevail.

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# AUGMENTED REALITY IN HIGHER EDUCATION

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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## ABSTRACT

Ville-Pekka Frantsi, Jouni Parkki, Markus Saarinen, Roni Tyrväinen: Augmented Reality in Higher Education
Technology: Augmented reality
Context: Educational industry
Lens: Current

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This study aims to find out the current state of Augmented reality in the higher education use worldwide in general level. We are trying to find different use cases for Augmented Reality in theoretical and practical teaching in education. This study also aims to find the advantages and disadvantages of using Augmented Reality as a teaching tool.

The study consists brief look to the Augmented Reality in general and the history of Augmented Reality in educational industry. The second part of this study is about use cases and different ways of using Augmented Reality. Following benefits and challenges of Augmented Reality

for both students and teachers. The last part of this study is a short look of the future of the Augmented Reality.

As a solution this study presents different ways for using Augmented Reality as a tool for supporting teaching in the higher education level both in practical and in theoretical teaching. This study presents many different advantages and disadvantages in use of Augmented Reality.

Keywords: Augmented Reality, Higher Education, Present

## INTRODUCTION

Development of technology and innovations have improved the quality of our lives throughout the history and during the past decade there has been a lot of interest focusing on different virtual technologies, such as augmented reality (AR) and virtual reality (VR). Augmented reality has already been used in many different fields, such as tourism, maintenance and manufacturing (Palmarini et al., 2017). However, AR studies have been mentioned to be immature in education when compared to different technologies used in education (Garzón et al., 2019). To our understanding, augmented reality has not really been widely adopted yet in many educational institutions, which makes the topic interesting to look closer.

There has been found many different benefits, disbenefits and challenges for the augmented reality when used in education along different fields. The purpose of our research is to create a general overview of the augmented reality in education and to describe what kind of effects this technology has for example on students and teachers in learning situations currently. We will also briefly address what kind of opportunities AR might have in educational settings and shortly provide insight about the use of AR in the future in education. The benefit of our report is that it offers general overview of the both technology and its effect in education while the method itself is a literature review.

At the beginning of this report, we will briefly explain what the AR technology is and the how it has been used in education. The more theoretical and practical side of using AR in education follows this and lastly, we will go through what kind

of effects the technology has on students and teachers before providing sights of the AR in education in the future.

## AUGMENTED REALITY IN GENERAL

The birth of augmented reality can be traced to the 1960s when Ivan Sutherland wrote about his working prototype of the first head-mounted display which was later used as a viewing device for augmented reality. The term “augmented reality” was first used in the 1990s. (Rabbi, I. & Ullah S. 2013). Few years later, the rise of augmented reality started around the start of the new millennium.

Augmented reality is a technology which combines a virtual world and the real world in real time. While virtual reality creates a completely virtual world, augmented reality allows users to interact with the real world. The interaction between the real world and a virtual one should happen in real time. The augmented reality should also be registered in three dimensions. These three points were included in the very first definition of augmented reality that was made by researcher Ronald T. Azuma in 1997 and this definition is still widely used.

AR applications can be categorized based on the technology they use. A common classification splits them between image-based and location-based applications. Image-based applications use images, graphics and tags as identifiers and location-based applications use GPS (Global Positioning System) or other positioning methods. (Yilmaz, R., & Göktaş, Y., 2018).

There are many different platforms where augmented reality can used. The common ones are different AR glasses or head-mounted displays, smartphones and tablets, personal computers with webcams and kiosks, digital signage and windows displays. The common nominator for all these platforms is that they all have cameras. Platforms also need tracking and sensing systems (GPS, compass, accelerometer), a network infrastructure and software or an application itself. (Kipper, G. & Rambolla, J. 2012).

Augmented reality applications are already used in various different industries from the medical industry to the retail industry (Alkhamisi, A. & Monowar, M., 2013). The educational use of augmented reality started in the beginning of the 2000s (Azuma R. & al., 2001). First applications were used to teach geometry.

However, Bacca & al. (2014) made a systematic review about research and application trends in augmented reality use in education between years 2003-14 and concluded that augmented reality was still in its initial phase and has not spread widely in education world.

Yet many researchers have said that augmented reality is still in its initial phase and the augmented reality market is expected to rise from around 6 billion U.S. dollars up to 198 billion U.S. dollars by the year 2025 (Statista, 2018).

## AUGMENTED REALITY IN EDUCATION

### The Theoretical Side of Augmented Reality in Education

**Table 1:** Application of augmented reality in education

| Application area | How it is applied | Reference |
|---|---|---|
| Medical | Interacting with virtual patients. Teaching human anatomy. | Kuehn, 2018 |
| Construction | Safety and hazard analysis, co-operative learning. | Akeem, et al., 2014 |
| Biology | Navigate a virtual space to teach students how to measure water quality and how to spot differences in water quality. | Kamarainen, Amy et al., 2013 |

GPS-systems can be used in tandem with augmented reality systems to provide users with simulations depending on their location (Dede, 2018). Smartphones are already using this kind of technology with simple augmented reality games, like Pokémon Go. These kinds of applications can be expanded on as smartphone and handheld technology makes further leaps forward.

Head-mounted displays, such as glasses or helmets can be wirelessly attached to a mobile device, such as a smartphone or tablet to computational power with more immersion computational power on the move. Cloud technologies and cloud computing are also ways of providing mobile augmented reality setups with major computational power.

Immersive virtual reality rooms could also serve as a way to teach students subjects like physics or astronomy. With the use of touch features, haptics, forces like the wind or someone touching the user, motions, vibrations or any physical

sense of touch that the augmented reality room can instill on the user can make the situation feel immensely more real for the user (Dede, 2018). Stereoscopic sound is another way to make a virtual object seem like it is a part of the real world.

HoloLens-technology can be used to project three-dimensional computer-generated scenery into a classroom in for example medical education. This can lead to interesting ways of teaching students subjects such as human anatomy. It can also be applied to other fields of education, such as construction safety education and architecture.

Another future application of augmented reality is in teaching construction safety and spotting hazards in a real construction site using a helmet or glasses with a virtual user interface. Akeem, et al. (2014) used a virtual social reality application to create a virtual construction site with predetermined hazards for students to spot and discuss with each other.

In a virtual space, students can safely analyze a construction site and learn what safety hazards manifest in what ways without being at risk themselves. Such a system can also provide instructors with ways to teach equipment inspection in safe and harmless ways to students. Such as system provides a way for students to learn from their mistakes without causing bodily harm to themselves or others, a valuable tool for a hazardous industry.

This technology could be used as a method to safely inspect real construction sites and used as a learning tool for students in construction safety. It can also provide a way to simulate real construction hazards in a real construction site.

## Augmented Reality in Practical Use

The EcoMOBILE project was developed to use two separate augmented reality technologies: it combines augmented reality with environmental probeware during a field trip to provide students with an interactive experience. The system was used to teach middle school students about water quality measurements and to deepen their understanding. The augmented reality device provided the students with different spots to measure water quality at. Students used mobile wireless

devices to navigate the virtual space and to observe virtual media and information using an application. (Kamarainen, Amy et al., 2013)

Augmented reality devices can provide large benefits for any education space that features hard-to-replicate materials or nearly once-in-a-lifetime situations. One of these is medical training. In medical training using devices combining augmented reality and a virtual space, students can explore a human being from within, which leads to increased results in learning hard-to-learn subjects such as human anatomy. Augmented reality devices are also used to teach nurses and doctors how to interact with patients. (Kuehn, 2018)

These devices are used to teach surgeons and other medical practitioners how to perform difficult surgeries; performances which would be hard to replicate without a real human body without augmented reality devices. While rather new in the medical space, these devices have shown to improve learning amongst medical students and provide them with more confidence when presented with a real patient. (Kuehn, 2018)

Is it also important to suspend the user's disbelief in order for their learning capabilities to be improved (Dede, 2018), via an immersive overlay, immersive graphics or other ways to disguise the fact that the user is interacting with a virtual world inside a real one. As such augmented reality should feature as immersive interfaces as possible to stimulate learning, as immersion is important for learning.

With the technological advances come difficulties getting users accustomed with new devices and features. Technical issues and having to teach students how to use the devices and programs lead to more overhead on the teacher; basic knowledge in computer usage is required, however some devices might require more specific knowledge. As such, new, fancy devices are not the only things required, qualified staff is also an important part of integrating augmented reality into learning. (Dede, et al, 2017)

# EFFECTS OF USING AUGMENTED REALITY IN HIGHER EDUCATION

## Effects for students

Adopting augmented reality to teaching changes students' learning experiences, both positively and negatively. These changes are discussed in this chapter. Many of these changes were found by Akçayır's and Akçayır's (2017) systematic review of the literature of augmented reality usage in educational environments.

One of the key findings in Akçayır's and Akçayır's (2017) review paper was that augmented reality can boost learning results. There are many reasons for this. Augmented reality can motivate and create a positive attitude towards learning and therefore make students more interested to learn more. (Koçak et. al. 2019; Akçayır and Akçayır, 2017) AR also allows students to learn through play more easily. (Akçayır and Akçayır, 2017) AR also helps to improve retention which means that students will remember and learn things more easily. (Koçak et al. 2019)

There are also signs that AR could reduce incidental cognitive loads, boosting learning performance even further. However, there were some opposing findings that indicated that AR could cause cognitive overload because of the amount and complexity of AR material. (Akçayır and Akçayır, 2017) It is possible that this issue only depends on the usability and use-cases of the system and could be solved in the future with further research because usability issues were the most common problem found in Akçayır's and Akçayır's (2017) review.

Augmented reality can also make learning more fun and entertaining. It also allows teachers to give more responsibility to students which increases the engagement of students. (Akçayır and Akçayır, 2017) This means that AR could allow students to study more independently instead of fully relying on their teacher. Even though students are more independent, they still interact more with other students, learning material and with the teacher when they use AR (Akçayır and Akçayır, 2017; Koçak et al. 2019). There were also some findings that AR could enhance student's learning interests but only a few studies had researched this, and more research is needed to confirm this (Akçayır and Akçayır, 2017).

Augmented reality also brings new ways to visualize and interact with the content that is being taught. This could help the students to understand complicated concepts and phenomenon. (Akçayır and Akçayır, 2017) This could also help students who learn and understand things easier when the content is clearly visualized. It also helps students to become more creative (Koçak et al. 2019).

As already mentioned above, augmented reality's technology allows students to be more independent. Depending on technology and environment where it needs to be used, AR also allow students to learn everywhere. (Koçak et. al. 2019) Students do not necessarily need to be in a class or even at home to be able to learn more or do their assignments for example. This also allows students to progress in their own pace (Koçak et al. 2019). This could be helpful for those that are learning slower or faster than the rest of their class.

Most common problems that augmented reality could cause, cognitive overload and usability issues were already mention above. Other problems with AR are mostly technical. These could be anything from inaccurate GPS to broken hardware. (Akçayır and Akçayır, 2017) These kinds of problems could cause negative attitudes towards AR and therefore reduce the interest of students and possibly make all the positive gains from AR ineffectual. AR-systems also require some training or know-how which might not be something that every student wants to do, and the results might not be as good if a student is "forced" to use AR-systems (Koçak et al. 2019).

**Table 2:** The effects of using AR in education for students

| Benefits | Challenges |
|---|---|
| Increased learning results | Cognitive overload unclear |
| Independent learning | Usability issues |
| Understanding the content better | Technical problems |
| Improved retention | Requires some know-how/training to use |
| Increased communication between the students | |
| Allows students to progress in their own pace and in any place | |

## Effects for teachers

Even though the augmented reality has been studied to have a wide range of effects on the students, the technology affects also the many other sides. However, the literature seems to have focused more on the student's perspective while the effects of AR for other parties, such as educators, are not that well studied yet. There can be found a large variety of effects, both positive and negative, and challenges when considering the use of AR in education from the teachers' perspective. Many of the positive sides, such as increased learning outcomes, using AR as a tool during education could be speculated to be realized on the students' side while the negative sides, experienced by the students may affect the educator's work. In the literature, it seems that the negative sides are more often mentioned than the positive. This could be due to our understanding that the AR technology is not that common or even mature technology yet to be adopted in wide use and this creates a lack of information in that perspective.

Few of the negative effects found were related to the usability and technical problems for the students, however it was mentioned that it is not clear whether the usability issues were caused by the technology itself. Other challenges for the AR found by educators were related to the training of staff and students as well as having support team to assist with the technology. (Khan et al., 2019) It could be argued that well designed training could eliminate some of the technical problems and in that way make the use of AR easier. On the other hand, it also may be that limited skills of educators regarding the AR could also prevent the full potential usage of the technology.

Regarding the use of AR in education, Bower et al. (2013) has mentioned how the educator's skills, such as facilitation, appears to be a critical factor when considering the students' learning and feel of challenge from the activities. The study has further addressed how the educators' knowledge and different use of the pedagogical approaches are key factors to enable the learning of students when using AR, especially in the design-based learning, that have been studied to improve the learning outcomes. Based on this, it could be said that the role of an educator is still very important factor in many ways, since the AR may enable the use of different approaches in teaching and provide new opportunities for designing the content.

At the moment, there are several platforms and software tools that can be used develop applications for AR. The tools and applications however often lack features for education purposes, or they are behind paywall and would require financing (Tzima et al., 2019). Without the skills or proper tool to create new content, the educators would have to rely on the existing content. Khan et al. (2019) have commented how AR application's content can generally be inflexible and how this would limit the adaptability in lectures. Since the educators may not have enough skills and resources to create the content they require, outsourcing could be one solution for the problem. However, Tzima et al. (2019) has explained how important it is for the outcome that the teachers are involved in the content development process because of their expertise in the pedagogic field. It could be possible that one of the negative side effects of using AR technology for teachers is the increasing workload and time used when for example designing the content for lectures. The adoption of AR in education would cause educators the need of technical skills and continuous training regarding the AR, since the technologies are often changing over time (Tzima et al., 2019).

Augmented reality devices with location-based virtual overlays using real world data improve learning when used appropriately, but it is not enough to simply bring these devices to a classroom and expect instant results. As with most technological advances, augmented reality devices will need to be tailored towards educational use: being immersive is not enough, effective guiding of the learning process is also required through conventional means, such as guided social constructivism or situated learning (Tzima et al., 2019).

**Table 3:** The effects of using AR in education for teachers

| Benefits | Challenges |
|---|---|
| Enables the use of different pedagogical approaches | Usability and technical problems |
| Independent learning for students | Training for educators and students |
| Better learning outcomes for students | Designing and creating AR content requires additional skills |
| Engagement with students in learning situations | Increased workload |
| Allows the educators to use more of their imagination when designing lessons | The limitations of the tools to create AR content for educational purposes |

## DISCUSSION

There are some parts of augmented reality that need to be further studied and developed. The technology has progressed a lot during the last decade but according to studies we reviewed there are problems with software, especially in usability and ergonomics of the system. Better usability creates better experiences with the system and happier users are more likely to recommend AR-systems to their colleagues. Systems with great usability and ergonomics also consider all kinds of users who might have disabilities or cognitive limitations for example. According to Garzón et al. (2017) only 2,5% of their examined applications take into consideration possible special needs of their application's users. This needs to be changed because AR has potential to help those who have problems to study in same pace in normal teaching and studying environments. It is also important that AR systems are built so that they can benefit everyone equally and not isolate some students from others only because of AR-systems bad usability to users with special needs.

Another issue with AR that needs to be solved is the AR-content. There needs to be more content available and enough people with pedagogical backgrounds involved when developing content for augmented reality systems. (Garzón et al. 2017) This is similar problem to usability issues where AR's main goal has been to make augmented reality systems for education possible technologically, but usability and the quality of pedagogical content has been secondary. One way to solve this issue would be to have teachers create their own teaching content but this requires at least some technical knowledge and especially interest to do that. In some studies, there has been signs that some teachers can easily turn against augmented reality systems because they do not have control of their teaching content. Allowing teachers create their own content could also solve this issue (Koçak et al. 2019). On the other hand, some teachers are against AR because they have no interest to use more technology in their teaching because they are not comfortable with technology in general and asking these teachers to also create their own content would not work. Therefore, it would be better if there was more professionally created AR-content available but also an ability for teachers to modify this content when necessary and maybe a toolkit where teachers can create their own AR-content.

Augmented reality also needs to be further tested in different fields of education. According to Garzón et al. (2017) there are some educational fields, such as business and administration, where the use of augmented reality has not been studied at all. Some fields, such as engineering, has had much more research but findings from these fields might not be applicable to other fields and having studies made in different fields might give new insights to already researched fields, like engineering. Garzón et al. (2017) also think that AR needs to gain more interest in the industry. This could give AR in education a boost both in development and usage. Business benefits of using AR in education have not yet gained large interest of businesses and this needs to change before AR can be fully adopted in education.

## CONCLUSION

In conclusion, augmented reality is relatively new technology in the educational industry and the applications are in constant development. Number of studies of augmented reality in this field is rising. It is very safe to say that augmented reality will have huge impact on the whole industry in upcoming years. As a technology augmented reality is expected grow rapidly and there are no reasons not to believe that the effect is same on the education industry.

Currently there are already use cases from many different university and college disciplines from construction education to medical education. Immersive virtual reality rooms can serve as way to teach highly theoretical subjects such as physics and astronomy. HoloLens-technology can be used to project three-dimensional computer-generated scenery which can lead to very interesting ways of teaching things like human anatomy.

Augmented reality is also used in practical use where medical teaching is probably the best application. Augmented reality can provide situations which are hard to replicate in educational purposes. Augmented reality devices are also used to teach medical students how to interact with patients.

Researchers have found many different ways how augmented reality can improve students learning experience and results. Studies show that augmented reality can motivate and create a positive attitude towards learning and there

make students more interested to learn more. Some studies even show that augmented reality can reduce incidental cognitive loads. Augmented reality can make students more independent on their studying and make them interact more with each other. Besides all the advantages, augmented reality also brings disadvantages. Most common ones mentioned were usability issues and technical difficulties.

Most of the studies are focused on the student's side of the learning process. Effects on educators are not that well studied yet. Few of the negative effects found were related to the usability and technical issues and training of the staff and students and the lack of support to assist with the technology. After all, educators' skills are critical factor on learning process and how well augmented reality supports it. Teachers should also participate in content creation which can increase educators' workload.

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# THE THREATS IN AR CLOUD

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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## ABSTRACT

Mikko Hentula, Janne Sarja, Katri Tuunanen:
” The Threats in AR Cloud”

Technology: AR
Context: Consumer AR Cloud
Lens: Threats in development

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This report takes a look at AR Cloud and focuses especially to threats related to it. The report aims to first define what is AR Cloud and what are its potential use cases. Secondly, the report aims to identify possible threats and factors which could cause problems for businesses developing public consumer applications and solutions with AR Cloud. As a result, threats and factors were divided into 4 different risk categories which were then used to find more threats from within these categories. These four risk areas representing these categories are legal, ethical, physical, security threats. Considering threats and factors from these risk areas can create a solid base and reduce risks when developing consumer AR Cloud applications. The report is based on literature review along with our own pondering.

Keywords: AR, AR Cloud, AR Cloud threats, AR Cloud risks

## INTRODUCTION

Nowadays, AR (Augmented Reality) applications are mainstream, at least in the developer point of view. They are easy to develop, since there are many software development kits to easily build AR applications. (Inbar 2018) Devices that can run AR apps are no longer hard to find, either. For example, many modern smart phones have a depth-camera.

According to Gartner, AR Cloud will enable significant new business models and ways to interact over this decade (Stamford 2019). Inbar (2017b), who coined the term in 2017, claims that at some point in the future, the real-time 3D (or spatial) map of the world, the AR Cloud, will be the single most important software infrastructure in computing.

AR apps are struggling, because in many cases they lack the sharing, communication and collaboration aspects. The AR Cloud makes it possible to create something in the AR Cloud world, that is accessible for other users, too. It provides “a persistent 3D digital copy of the real world to enable sharing of AR experiences across multiple users and devices” (Inbar 2018). Thus, it is good for sharing and collaboration in AR experiences with many users.

A key role for computer security and privacy research is to anticipate and address future risks in emerging technologies (University of Washington 2019). For AR applications, new unique kind of data is being captured, meaning the 3D mapping of the world, its actors and the metadata related to this. (Miesnieks 2019) If the companies are not mindful of privacy rules, they can be facing legal sanctions and having to completely re-engineer their products (McFarlane, 2017). Also, AR technology has the potential to completely remake social institutions and change the way we think in the future (Brinkman, 2014). We see that AR Cloud creates many great opportunities in the future, but the risks it has should not be underestimated, and this is why we want to dig into the dark side of AR Cloud.

In this report, we utilize the ETAU Framework. We chose AR Cloud as the emerging technology, in the context of consumer use. Our perspective to the topic – search lens – is focusing on the threats that arise from the use of AR Cloud applications meant for consumer use. Thus, in this report, we consider the things that should be taken into account when designing consumer AR Cloud solutions. In order to better understand the concept and characteristics of AR Cloud, we also discuss the term and aim to define its main elements.

The structure of the report is the following: First, we present the concept of AR Cloud, its characteristics and demonstrate what makes AR Cloud applications different from regular AR applications. Next, we consider the four risk areas we discovered: legal, ethical, physical and information security related risks. Finally, we discuss the meaning of our findings and their limitations and suggest possible future research topics.

## AR CLOUD

Augmented Reality (AR) is a presentation method that shows the artificial digital object as supplements with the real world. Another related term is Mixed Reality (MR), which mean environments that merge elements of physical and virtual worlds into a single immersive experience. The Cloud, on the other hand, is a computing architecture, from where the resources can be called when they are needed. The main benefit of it is that it can accommodate any compute and storage requests made by an application. (GSMA 2019)

Ori Inbar coined the term AR Cloud in 2017. He explains that AR Cloud provides "a persistent 3D digital copy of the real world to enable sharing of AR experiences across multiple users and devices." (Inbar 2018). It is a new way to organize the world's information and making it accessible. The AR Cloud makes it possible to create something in the AR Cloud world, that is accessible for other users, too. It is good for sharing and collaboration in AR experiences with many users. (Inbar 2018) It has also been described as the digital twin of the world. AR Cloud is not a single service, but instead it works as an infrastructure for a myriad of services of the new era. (GSMA 2019) It could be said that it's like another layer placed on the real world.

### Ingredients of AR

Inbar (2017b) presents the three elements that create the foundation for AR Cloud.

The first one is a scalable, shareable point cloud. For AR Cloud applications to work accurately enough, there needs to be a persistent, always accessible 3D map of the world that is aligned with the real-world coordinates. It should understand geometry and shapes of the world. The scalability is important, because the AR Cloud should be able to understand large spaces and connect many such large spaces to even larger clusters. In addition, it should allow regular users to contribute and it be able to build and refresh over time. (Inbar 2017b)

The second element is an instant, ubiquitous localizer. With GPS this is not possible, because it is not precise enough (Chuang 2019). The ideal AR Cloud localizer will be able to localize against a vast set of local point clouds from any given

angle and can share the point cloud with multiple cross platform devices. This opens a new possibility for multiple users to interact with the virtual object in real-time, at various angles and remotely. Each person will be able to experience the virtual object in his or her unique point of view. (Inbar 2017b)

The third element is the real-time multi-user interaction. This is a familiar thing in traditional multiplayer video games, but with augmented reality, it is something new. With AR Cloud applications, many users can interact with persistent content and each other in real time, in the real world. (Inbar 2017b)

The VR/AR Association Cloud Committee defines AR Cloud as a continuously updated collection of machine-readable datasets, primarily sparse or dense point clouds plus meta-data for each point or groups of points. AR Cloud data is any dataset which can aid in accurately determining the position and pose of AR-enabled devices, semantically understanding the scene and positioning digital content in physical spaces. (Chuang et al. 2019)

Based on the literature searched, we found six main characteristics of AR Cloud. They are rather complementary: the digital 3D map of the world is in the core of AR Cloud, but it requires other additional characteristicts and features to complete the definition of AR Cloud. This is why we present the elements with an onion diagram in Figure 1.

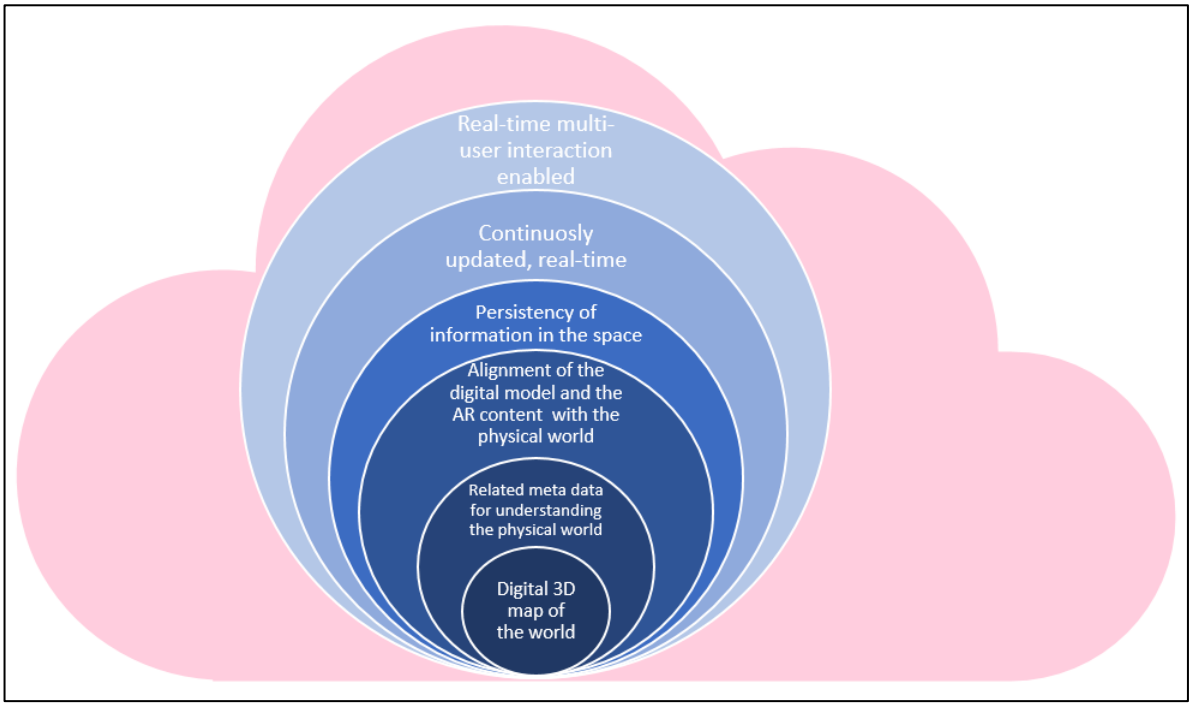

***Figure 1: Elements of AR Cloud***

In the core of the onion, there is a scalable, shareable digital 3D model of the world. (Inbar, 2017b; Miesnieks, 2018; McMenamin, 2019) The second layer that complements the digital 3D map, is related meta-data for understanding of the physical world (Chuang et al., 2019; McMenamin, 2019). Next, comes the ability to align the digital model and the AR content with the real world itself. (Inbar, 2017a; Chuang et al. 2019) The fourth layer is the persistency of information (AR content) in the space (Inbar, 2017b; Miesnieks 2018; McMenamin 2019). The second-outermost layer is that the AR Cloud must be continuously updated in order to function in real time (Inbar, 2017b; Chuang et al., 2019). The last, but definitely not the least, layer is that the AR Cloud enables real-time multi-user interaction with the AR content (Inbar, 2017b; McMenamin, 2019; Miesnieks, 2019). These layers altogether construct the concept that we know as AR Cloud.

## Use cases: What is AR Cloud and what is not?

It might be slightly confusing telling AR and AR Cloud applications apart. The previously presented elements of AR Cloud are the main characteristics, but to make it a bit more clear, we will be presenting some examples and possible use cases of AR Cloud.

For example, in the original Pokemon Go, AR Cloud is not used, but regular AR technology is. The AR characters do not understand the spatial context of the surrounding area. They don't know that there is an object next to them, and they for sure don't know that it's a chair from IKEA. They are not aware of their changing location in the world and they can't interact with the Pokemons in another Pokemon Go player's screen, because they only exist on the screen of one player, even though their data can be saved to the system.

Shareability and persistency of AR Cloud content is one of the characteristics of it. For example, an artist could place their 3D virtual art in a park for the community to interact with it, regardless of which device they use. The 3D virtual art will "live" in that space as if it's really there and will not disappear between different app sessions.

Face filters are a common feature on many social media platforms, such as Instagram or Snapchat. They utilize AR technology to recognize the face and to add a virtual element on it. But imagine a face filter that could be seen in real-time by the people around you that use different end devices. This would be AR Cloud technology.

These are just some easy examples and assuming that AR Cloud will be popularized as a visual interface for digital information systems in the future, the use cases for it are almost endless. Initial use cases of AR have focused on consumer applications, such as gaming. However, in the future AR Cloud has a huge potential in industrial applications, too. (GSMA 2019) Other potential use cases are construction, real estate, autonomous navigation, education and training and culture (Chuang et al. 2019), to mention some.

## Technology

A primary enabling factor for AR use is the technology. This includes end-devices, network and the distributed cloud, or “edge” (GSMA 2019). We won’t go too deep into all of these, but the whitepaper by GSMA (2019) encompasses these very well.

The end-device can basically be anything with a depth-camera and a screen in it. Usually that is a mobile phone, but also AR glasses, or more futuristic, AR lenses could be possible. (Chuang et al. 2019) Affordable head-worn AR devices aren’t yet available, and this is why most of the applications are created for mobile usage (GSMA 2019). Nowadays, many AR applications only recognize flat surfaces, but with depth-cameras, a more specific point cloud can be created to better model the environment. (Chuang et al. 2019)

5G networks will have a big role in supporting the transport of information of billions of people. (GSMA 2019) For AR Cloud to work in real-time, 5G network connection is needed. It enables the users to interact with the AR world objects simultaneously and to also share the information on their environment instantly. Then, a cloud platform infrastructure is needed for building and maintaining the environment and to coordinate the applications. (Inbar 2017)

To create realistic AR views, a lot of data needs to be gathered. For example, to render a virtual object on a real table, accurate understanding of the table geometry and position in the real world's coordination system is needed. However, information is needed also on whether there are real objects on the table. Some of them might partially hide the table and the objects can be also semi-transparent (such as a water bottle). Additionally, information on the lighting conditions of the environment is needed for the exact visualization of the virtual object. (GSMA 2019) Also, the user could be tracked very precisely, from their location and device orientation to eye-tracking and real-time modeling of their posture. (Miesnieks, 2019) For environment sensing and input tracking cameras, depth sensors, light sensors and eye-tracking technology are needed, to mention some. (GSMA 2019)

To acquire this amount of data and to keep it up-to-date, crowdsourcing is the best option. This means that while using an AR Cloud application, data is collected from the users, and new models are created and shared simultaneously. The models could be built in real time, on any device, and on a very large scale. (Inbar 2017b)

Privacy is a sensitive issue when it comes to AR Cloud. The constant creation of models of our surroundings is somewhat questionable when it comes to privacy. Having no control over what data the people who walk past your house will gather or to what purposes this data is used sounds indeed scary. That is to say, it should be controlled, what is being captured and saved into the cloud and how. Miesnieks (2018) addresses this concern by telling that the data needs to be anonymized, and no image data should be saved. Rather just machine-readable point clouds, that can't be reverse engineered back into a human-readable image (Miesnieks, 2018). However, since the building of AR Cloud is what it is, some privacy issues need to be covered. In the following chapter(s) we will discuss further, what kind of risks AR Cloud applications might produce.

## RISK AREAS

In this section we aim to introduce different areas that will affect the AR Cloud businesses. From each area we aim to identify problems that might arise if certain threats or factors are not considered when developing an AR Cloud business or applications. The aim of this section is quite similar as in PESTLE analysis which aims to highlight areas that affect the business but might easily go unnoticed. Further on this kind of a strategic analysis and planning tool can reduce business threats in the long run. (Frue, 2016) However, we didn't want to use an existing tool to do this analysis but rather we wanted to identify for ourselves the most interesting or important areas that we wanted to consider.

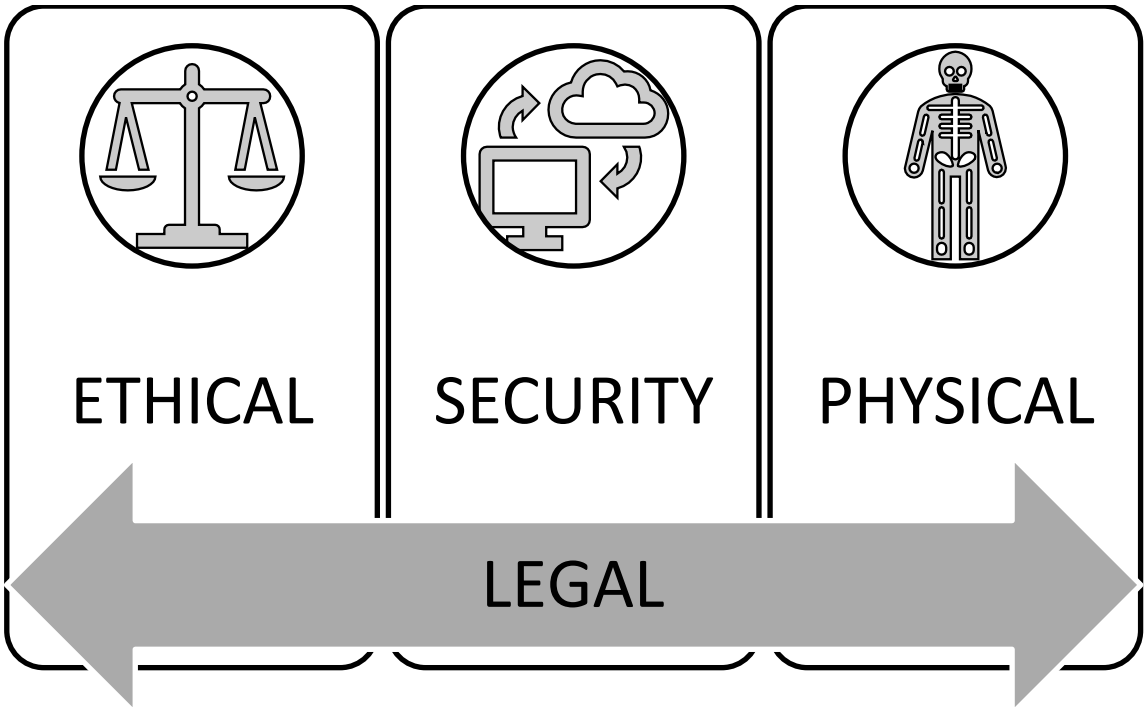


***Figure 2: Identified risk areas***

The identified risk areas are *legal*, *ethical*, *security* and *physical*. These are depicted in figure 1. The legal risk area also reaches the other three areas, therefore it is pictured in such a way.

### Legal

The legislation is obviously one of the most important things to take into account when developing any new business. For example, it is not unheard of that a new up and coming business fails if privacy legislation is not respected. (Brimsted,

2016) With legislation, there is a different dimension to consider. First of all AR Cloud businesses should recognize which different legislative areas can affect the AR Cloud. For example, property laws, privacy legislation as well as copyright and intellectual property rights can all be factors that need to be considered as AR Cloud develops. (Cook et al., 2019) Secondly, the scope of regulations needs to be considered. AR Cloud application can have users from all over the world meaning these users can be under widely different legal systems. This can easily lead to an inter-jurisdictional mess. For example, privacy legislation differs between the USA and Europe. (Healy, 2019) So, AR Cloud businesses should not only be considering different parts of legislations that can affect AR Cloud but also be aware of how these legislations are implemented in different markets. The AR Cloud technology will also move forward quicker than laws which calls for the technology companies to collaborate with governments when new legislation is developed (Cook et al., 2019; Healy, 2019). So, lastly, AR Cloud businesses should also be aware of how the legislation is going to develop in the future and how they can potentially affect it.

## Privacy

One of the most obvious and important legislative aspects regarding AR Cloud will come from privacy legislation. A lot of privacy concerns have already been raised towards AR and especially AR Cloud solutions. For example, with wearable AR devices like Google Glasses concerns have already been risen about privacy from both users of these devices as well as third persons that are being part of the device's environment. (Kotsios, 2015) As AR solutions become more widely adopted there will be more and more data recorded about individuals and their surroundings. This raises many concerns around data privacy like who owns the data, how it should be stored securely, and who has the right to access it. (Cook et al., 2019) With the development of AR Cloud individual people probably also become more aware of the amount of data that the AR Cloud applications can capture meaning these concerns most likely won't decrease in the future either. Therefore it is important, especially for AR Cloud companies who most likely will be having the biggest needs and possibilities to collect some form of personal data from the environment, to be aware of current privacy legislation as well as

possible developments in the future that could be caused by these most likely increasing concerns towards the technology.

There is no single all-inclusive and complete definition of privacy, and it is not just a single-layer legal concept. Rather it is a multi-layered concept that brings together aspects related to law, social and economic environments, and politics. Protecting the privacy of individuals means that they don't need to fear constant surveillance and the environment offers free and unbiased development for individuals. (Kotsios, 2015) Information technology development, increasing ability to gather data about individual users and effective ways to extract value from this collected personal data has raised more and more concerns about privacy in recent years (Givens, 2015; McFarlane, 2017; Nissenbaum, 2010). This has also reflected to the legislation. For example, the European Union recently updated its privacy-related legislation with the new General Data Protection Regulation (GDPR). The GDPR aims to introduce more liability for data processors and more heavily protect the rights of individuals. One of the goals of GDPR is also to encourage privacy as a cornerstone for the development of new products and services by highlighting "privacy by design" and privacy by default" approaches. (Brimsted, 2016) So, an important step for new AR Cloud businesses is to familiarize themselves with existing laws and regulations especially in their target markets.

Besides knowing the law, businesses should also identify what personal data they actually need and want to collect. AR devices and applications can already these days use GPS, microphone and camera (McFarlane, 2017). AR Cloud will emphasize their usage even more as data they can collect is a central piece of most AR Cloud applications. GPS, microphone, and camera can all record material that could be classified as personal data. Therefore, first steps for AR Cloud applications being developed could be to consider the balance between AR Cloud application's functionality and the data that is being collected through these different mediums (McFarlane, 2017). So, at least in theory, the less data the AR Cloud applications collect fewer privacy concerns need to be taken into account.

When it is clear what data the business wants to collect it is important to identify how this data is being used and compare it to the legislation. The electronic con-

tent has shifted towards customizable views that have exploded the use of personal data to hyper-target content, advertising and brands to individual users. This shift has made personal data more and more valuable for businesses. (McFarlane, 2017) With AR Cloud similar trends can be expected. McFarlane (2017) notes that much of the data that AR devices can collect from their surroundings can be classified as personal data. Therefore, the developers of AR Cloud applications need to be mindful of what data is collected and how it is handled or used in order to comply with applicable data protection laws when dealing with information that can be classified under personal data. If the companies are not mindful of privacy rules, they can be facing legal sanctions and having to completely re-engineer their products. (McFarlane, 2017)

Some of the legal privacy issues can be solved by having AR applications' users consent to collect the data and being transparent how the data is handled (McFarlane, 2017). However, with AR cloud the AR applications do not only collect user-specific data like users' home, speech or GPS coordinates. AR cloud applications are also primed to be used in public spaces where other people can also be recorded. This has already raised a lot of concerns when google glasses were introduced and raised questions if individuals have the right to decline being recorded while the glasses are scanning the surroundings (Kotsios, 2015). Especially with AR Cloud, these threats to 3rd party individual's privacy can get even more serious as the AR application doesn't only record individuals but also has the possibility to send this data onwards to remote servers. Kotsios (2015) notes that the recorded data can be for example sent to social media or processed with facial recognition or other biometric scanners which can create even more detailed personal records of these 3rd party individuals. With google glasses, these kinds of concerns have already led to the ban of them in many public places like bars and dressing rooms (Estep, n.d.).

As demonstrated here even with privacy legislation there is many different areas to consider. The basis is that companies should be aware of the legislation. Besides being familiar with privacy regulations the businesses also should have an understanding about their own data and identify risks in relation to regulations. It is seen that with careful planning and proper attention businesses can usually

comply with any existing privacy legislation. (Redgate, n.d.) It seems that regarding privacy the recording of 3rd party individuals might be the most problematic area. There are some solutions presented to this problem like using facial recognizing to first identifying all the individuals being recorded and the checking for example from some form of online registry if these individuals have given their consent to be part of the recording or if all data regarding to them should be removed. (Kotsios, 2015) However, these solutions don't sound at least yet too feasible and this is an area where new solutions are most likely needed in the future.

## Other legal aspects

There are also questions about what places can be mapped in AR Cloud. For example, with Pokémon Go, there were problems as players went to places like hospitals and Holocaust museums looking for Pokémon's. There have already been considerations from government agencies to develop laws that would require AR companies to apply for a permit to map their content in public places like parks. There have also been concerns about how much private property owners can control what virtual content is mapped and displayed in their property. (Healy, 2019) There are not yet laws or solutions on how these problems related to the mapping of AR content to public or private properties. With AR Cloud this problem will probably magnify as one of the premises of AR Cloud is to map the whole world. This is clearly an area that future legislation needs to address and that AR Cloud application developers should monitor carefully.

Closely related to the previous point is also to figure out the confusion of should the AR-related legal things go more under virtual and intellectual property legislation or physical space legislation. For example, disputes related mapping AR content to private properties have raised this question as property owners think that AR technology should be treated under physical property laws and conversely AR application developers see that the technology is part of the intellectual property rights. Therefore, it is implicated that some form of a hybrid approach is most likely as AR includes both real and virtual elements. (Judge & Brown, 2018)It is also important to note that legislation related to virtual spaces

is still in the initial stages and most likely will develop in the future as the use of VR and AR continues to spread (Healy, 2019).

Intellectual property (IP) rights from the physical world are also a factor to consider when developing AR applications. The basis of AR is to overlay virtual content on top of the physical world. However, there could be cases where for example company logos or some art pieces could be overlaid with virtual content and this way violate the IP rights. (Cook et al., 2019) This means that developers need to be mindful as they create content for applications and possibly seek relevant permissions and licenses when they are dealing with material that is protected with IP rights (McFarlane, 2017). IP right management could cause problems especially with AR Cloud as there is so much content in total that it is easy for developers to miss or overlook violations and on the other hand, these violations might popup easily as they are displayed to a large user base. Problems can also arise with AR Cloud solutions that allow users to create content for the application. YouTube is a good example of a platform where having users as content creators can cause problems with IP rights to the platform provider itself. Especially the EU's copyright directive which makes media platforms liable for copyrighted content can be very problematic for any kind of content platform. YouTube has had a hard time finding solutions to detect copyright violations and this could be a threat for many AR Cloud businesses as well. (Sands, 2018)

## Ethical

AR technology has the potential to be part of our everyday life, completely remake social institutions and change the way we think in the future (Brinkman, 2014). Therefore, it is also important to think ethicality of an AR solution. Especially with AR Cloud, these ethical concerns can be magnified as AR Cloud will make use of AR to be more part of our everyday life. For AR Cloud application developer's ethics come in when thinking about what is the right thing to do (Brinkman, 2014). Ethical factors are especially important to consider with quickly developing technology like AR Cloud. As noted already in the context of legislation, the AR Cloud is a technology that will most likely develops faster than the legislation. Since there is no proper regulatory infrastructure currently in place this could be tempting for some businesses to exploit. (Blum, 2018) For that reason, it is important

for businesses to also think if what they are doing is morally and ethically right even if it is not forbidden legislation wise.

One ethical point to consider is the level of immersion of the experience. Spending too much time in too immersive AR applications could cause users to have difficulties interacting with the real-world afterward. Especially with children's there is very little research about how the AR application could affect their behavior and distort their view of the real physical world. (Blum, 2018) This can become a real ethical concern especially with AR Cloud where the experience is not limited in one single location but could be present in all parts of our everyday environment and usage times could be longer. Therefore, from an ethical point of view, the developers should be considering if and how this could be taking into consideration when developing AR Cloud applications.

Another ethical concern could be that users are not able to identify what is real and what is virtual. In the future, the virtual content could evolve so much that it is practically impossible for users to distinguish these virtual objects from real physical objects. This would lead to opportunities for developers to distort the actual physical reality in misleading ways which of course could be unethical in many cases. Again, this could be especially harmful to children and people with special needs. (Blum, 2018) This naturally raises a question about how clearly the AR Cloud developers should indicate the difference between physical and virtual objects and how they should note these risk groups. (McEvoy, 2017)

Another ethical concern is content itself. For example, misleading information or advertisement could be shown in AR spaces. Or products in sale could be modified with virtual content to be more inviting looking for customers. (Blum, 2018) This power could be used in the opposite way too by trying to damage the image of other competing businesses. For example, there could be bad reviews highlighted, graffiti or other visually unpleasing content created virtually next to a business that could negatively affect this business. (Cook et al., 2019) AR Cloud can increase the scope of this problem. This can definitely distort the competition and AR developers should be very aware of the ethicality of this kind of activity.

## Physical

The main point with AR is that it in fact augments reality. That means that the user of augmented reality is interacting with the physical world at the same time. There are several physical threats to using AR that need to be considered when developing AR cloud solutions. One of the main areas of concern on the physical side is how the actual worn devices can affect the users. By this we mean mainly if the usage of such devices can cause eye strain, dizziness or such effects. Another area of concern is how the AR solutions affect the way the users interact with the physical world. Is it possible that the AR overlays cover up some vital matters from the vision of the user?

Only time will tell what kind of impact the large-scale deployment of AR cloud solutions can have on the physical concerns, but for now we can mostly make educated guesses based on the projected possibilities of AR cloud that were presented in chapter 2.2. There can be at least two major ways, that both are about the extent of the usage, how the usage of AR applications changes when the added possibilities of the AR cloud are taken into use. Firstly, the AR cloud could possibly expand the usage of AR from more safe private spaces to public spaces, city centres and so on. On the other hand, the usage of AR could expand from shorter sessions to longer periods of time. That would be due to AR applications getting more and more useful in day-to-day lives.

The possible negative physical effects such as motion sickness have been covered quite well within the VR realm, but not so much with AR. According to one study done on the HoloLens with AR training, most users will face no symptoms of motion sickness (Vovk et al 2018). Obviously, the devices differ quite considerably, and it could be possible that others cause more negative effects. However, there doesn’t seem to be any characteristics in the AR cloud that would seem to be able to change the potential of these kind of physical concerns with AR solutions.

The other area of concern with AR solutions, virtual overlays covering physical matters for example, may change with the introduction of AR cloud-utilizing AR

solutions. Describing AR in general, Roesner (2017) pictured malicious applications blocking an AR user's view of oncoming cars as they are crossing the street as a concern. This can be both a matter of physical security, as it can cause physical harm to the user, and information security, which is discussed more in the next chapter. A poor placing of an overlay could also be the consequence of bad software design, delay in connection to the AR cloud or simply a hardware failure. Would the concern of something like this then rise with the adoption of the AR cloud? Perhaps, as the AR cloud enables creating applications that are used in a wider range of environments than just AR trainings in a controlled factory setting for example.

## Security

Information systems have information security threats, so do AR applications, as they are parts of information systems. In fact, this threat category is mostly about information security threats. A few factors make AR quite interesting in terms of information security. Firstly, AR solutions consist of several different parts of technology, that can all be provided by different companies. There is of course the device and the software, but also perhaps a separate development and software distribution platforms, as well as even a connection provider. The different operators combined to the fact that the devices are able to gather massive amounts of data with all the cameras, microphones and sensors. The privacy concerns were already discussed in chapter 3.1.1 with the legislation context.

McMenamin (2019) raises the fact that AR cloud will lead to businesses mapping their own premises, that could contain business-critical information, as a reason for heavy emphasis on security, access control and privacy. Even though AR cloud application developers aren't necessarily involved with the mapping, they have to make sure the information is not leaked through their solutions. Ryznar (2017) lists many very essential cybersecurity matters of concern, but what is of special interest in the AR cloud is the cloud threat vectors. The cloud could be breached, as well as data moving between the devices and the cloud could be intercepted (Ryznar 2017). As there are both open-source and proprietary AR cloud projects ongoing, the members of the ecosystem also have to face the

challenge of balancing between securing the sensitive information, while simultaneously trying to enable sharing data to enable optimal value creation within the value network.

## DISCUSSION

The main goal for us was to present broadly different threats and factors that should be considered in order to reduce risks when developing consumer AR Cloud applications and businesses. The categorization to four risk areas hopefully helps with analyzing the threats and risks as well as with understanding how broad the scope of these threats and risks can be. This report won't be an all-encompassing road map to guaranteed success for AR Cloud businesses but hopefully offers a base and helpful insights for the development and risk assessment processes in AR Cloud companies.

The areas introduced in the previous chapter link and overlap easily with each other. Therefore, it is important to note that many of the different factors introduced in the previous chapter don't exist in vacuums but are dependent on other factors in other areas. Therefore, it is important to note that these areas served more as helpers in breaking down and conceptualizing the problems and threats we wanted highlight rather than as clear independent categories.

Breaking down the study of threats into four different areas helped us overall to grasp AR Cloud concerns and threats as a topic better. This division also helped to dig deeper into different areas and consider things that other ways we could have been missed. On the other hand, it is important to note that there could be threats outside these areas as well as inside these areas that are not brought up in this report. Our study is not all-inclusive listing of problems and threats related to AR Cloud development but aims to bring attention to some of the most interesting points that we found.

The main priority of this report was to identify problems that might arise when attention is not paid to certain threats or factors. Also, some propositions were made to solve these problems. Many of the threats were still left as unanswered because there might not yet be proper answers for these or because presenting

these answers would have required too profound and long explanations concerning the scope of this report.

The novelty of the emerging technology also complicated the search of material for this report as not that much have been researched and written about the topic and especially about the threats. Especially AR Cloud as a term seems to be still very new and rarely used. AR Cloud as emerging technology also presents some new or unsolved threats and problems. New problems combined with limited research and material means that there are many areas where reliable solutions to problems don't yet exist. Therefore, this report can also act as a source of topics in the area of AR that could or should be researched in the future.

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# SENSES ON VIRTUAL REALITY

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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# ABSTRACT

Yau Calli, Arathy Padinjattayil Raveendran Pillai, Berfin Ebrar Atabey:
SENSES ON VIRTUAL REALITY
Technology: Virtual Reality
Context: Now and Future
Lens: Describe; Apply and Scale

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Keywords: Virtual Reality, Senses, Full immersion

With the improvement of Virtual Reality, idea and desire of full immersion increased. Therefore, this paper aims to investigate if it is possible to integrate all senses to virtual reality for creating full immerse. For these it talks about the senses of hearing, touching, tasting mostly. The sense of hear and sight is already broadly used in virtual reality, so this paper mentions a little bit about them. First one by one it explains if, is there any technology exists right now for people to hear, touch and taste in a virtual space and it gives few examples from these technologies. And then it includes the benefit of creating or integrating these senses to virtual reality. It explains what humanity will or which industries benefits from creating these. This paper also explains how far we are from making these technologies mainstream. The problem with this paper was finding reliable sources and papers since there are not many technologies or devices created for integrating senses on virtual reality. Lastly, we come to a conclusion that it is possible to integrate every sense to virtual reality and also it is possible to combine them into a one device. But with current technology we can only come so far. So, to be able to create this kind of devices people still need technological improvements and most importantly time.

## INTRODUCTION

Currently, the virtual reality technologies mainly focus on the development of the senses of sight and hearing. Our group believes that the combination of virtual reality and the five senses, (including hearing, sight, smell, touch and taste), would be the total immersion. It can greatly enhance the virtual experience and have a greater users' satisfaction. It is therefore essential to find out solutions to implement every sense on the virtual reality. It is acknowledged that the development of the senses of smell, touch and taste is limited at the current stage, the essay would examine how far from making these three senses to become the mainstream.

There have been many works conducted world-wide to improve the senses in VR, which are touch, smell, taste, hearing, sight. Though many research works could improve and make it possible for the other two senses: Hearing and sight, there are some prominent works conducted to make the other three senses into VR. The context here is concerned on improving existing VR devices to make it total immersion. Also, the main focus is pivoted to users of VR, who lacks the experience of other non-existing senses in VR. The main objective of this paper is to incorporate the works that have been done in the world of VR till now, so that this paper should reflect the main researches done in the field of touch, taste and smell in VR. In other words, this paper is precisely a prediction of the future of VR, which in turn could be a pathway in VR devices to add other senses into existing VR technology.

The research lens we focused here is to describe, apply and scale the senses in VR. So this paper also studies about the past and present of VR and predicts the future VR. Though this paper includes research works from renowned scientists, it also encompasses recent technical works applied in this field. Hence this paperwork is done by collecting information about the existing technologies and by analysing how far they could add value to solve the problem.

The structure of the paper is made such that it should make the read less confused about the content. Hence a quite accurate structure is deployed. First section is the abstract, wherein the problem description is depicted in quite simple words. It is then followed by Introduction where paper addresses the problem in detail, describes more about the problem, states the objective of putting forward this paper and hence the intended outcome .Then each of the rest sections is purely discussion of three non-existing senses of VR at present, which includes present works of VR in the corresponding sense field, the predicted method's expected benefits. It is written under titles like current stage of corresponding sense in VR, benefits of this technology and how far these proposed works from the mainstream are. Hence, this paper is a clear-cut image of scaling the existing VR technologies.

## SMELL on virtual reality

## Current stage of developing smell on virtual reality

In this part, it is discussed in terms of: structure of the device, current brands and examples, how the device functions, what the device supports and the reasons why developing the device.

For the structure, the device usually not only generate scents, it functions to provide other senses, such as wind, water mist and heat. It is also named “sensory mask”. The mask is a clip-on device, which is compatible with most of the VR headset in the market, by using magnets and Bluetooth. Using the example of FeelReal’s sensory mask, it is compatible with Samsung Gear VR, Oculus Rift, Oculus Go, HTC Vive and Playstation VR (Feelreal, 2020). Focusing on the smell part, it consists of a few components, including the aroma cartridge, aroma capsule and scent generator fans.

At the current, there are few companies specialize on developing smell-functioning device on virtual reality. For example, FeelReal, Olorama Technology and Ubisoft, are the companies which focus on developing sensory mask, providing sensory experience for the customers. Smell is an important sense they focus on. However, there are recent complaints about the Nosulus Rift, developed by Ubisoft. Users are dissatisfied about the smell of scents, which they feel uncomfortable and believe that the device is unable to enhance their virtual experience (Passary, 2016).

For the functioning of the device, the device holds replaceable cartridges with few individual aroma capsules. The aroma capsules have a variety of scents, including food, drinks, flower and nature. They can be purchased through the official website of the sensory mask companies.

For the use and reasons of the device, the device supports games, movies and entertainment. The major aim of developing the sensory mask is to enhance the virtual experience in these fields. The other aims include providing the favorable living environment, and realistic experience which would not happen in real environment.

## Benefits

By the stimulation of smell, it enhances the users to immerse into the virtual environment.

One of the benefits is to induce the emotions and moods of the users. According to Serrano, Baños & Botella (2016), the stimulation of smell is enhanced in induce different emotions. The study has found out that under the VR and the stimulation of smell, it is able to enhance the emotions, such as the emotions of relaxation, joy, arousal, anxiety and sadness. Both the positive and negative emotions are able to be induced. The rate of inducing emotions under the VR and the sense of smell is greater that of only under VR, showing that the stimulation of smell is useful in inducing emotions.

Another benefit is, the stimulation of smell is also efficient in improving sense of presence and mood induction (Serrano, Baños & Botella, 2016). Not only does VR provide senses of sight and hearing, it also provides sense of smell. Using the stimulation of smell, it helps the users to immerse into the virtual environment and making it sensory to become into the reality. The presence of scents would enhance the mood induction, which is different from emotion induction. The mood would last longer, and the VR experience would probably become an unforgettable memory.

## How far from making it to mainstream

In the current VR market, it is mainly focus on the senses of sight and hear, the sense of smell has not yet become the mainstream, there are a few limitations and concerns of the smell function.

First, there are concerns about the toxic chemicals of the scents. There are probably harmful and toxic chemicals contained in the scents, the harmful substances may be disadvantaged to the physical health and mental health of the human (Zanolli, 2019). The scents released was relied on the fragrances stored in the aroma capsules. In order to produce the favorable scents, the manufacturer would add the chemical substances to the mixture. However, to minimize the cost, some of the manufacturers would add the favors contained of toxicity. For example, acetaldehyde is a chemical which is able to produce fruit scent, however, it is carcinogen and increased the risk of getting cancers. Another chemical, acetonitrile, would also cause headaches, tremors and paralysis, as well as leading to convulsions and death when dosing the chemical in long term. Study has also shown that, styrene oxide is irritant to skin and eyes in animals testing, and increased the risk of suffering depression (Carlson, 2012). The toxic chemicals contained in the fragrances are detriment to the normal functions of human body and affect the health. It is seen that there are some manufacturers using toxic chemicals in the manufacturing process, especially usually happen in low-developed countries, such as China and Vietnam. One of the causes of it is due to the lack of law regulation of using toxic chemicals. To making the sense of smell into

the mainstream, it is suggested that the government of the manufacturing origin should tighten the law of using the toxic chemicals. The government should set the limit of volume of using the toxic chemicals per each aroma capsule, and minimize the amount used as well. Some of the chemicals contained higher toxicity should be banned and should be replaced by the natural substances. By producing safe and qualified fragrances, it can enhance customer confidence and attractiveness in the market, making it to become the mainstream.

Second, there are safety issues of the sensory mask. The structure and design of the sensory masks is complex, not only it focuses on producing scents, it also combines with other electric components to produce different scenes, such as wind and heat. It is important to consider the temperature and humidity issues when operating the sensory mask. When the different components are operating simultaneously, such as heat and smell, the electric current would increase, the cable surface temperature would then follow to increase. Without proper maintenance and not powering off immediately, thermal breakdown may occur, leading to phase-to-phase short-circuit tripping, finally cause serious fire. Also, if the scent operating fans are not working normally, the machine would become over-humified, accelerating oxidation and leakage. The sensory mask will be unable to energized and damaged due to the oxidation of the metal contacts. As the sensory mask is closely in touch with the face, when there is little explosion due to over loading of the current, the skin of the face would be damaged, and it may also further damage the eyes and nose components, affecting the appearance and the body functions. Though most of the companies had done several testing on the loading current, the companies should ensure the quality of the sensory in the manufacturing process, either the quality of the electric wires or the assembly process, to guarantee the safety of the sensory mask, making it to become the mainstream.

Third, the perception of smell is different among people. It is known that mostly people have the similar perception of smell towards certain kind of common goods, for example, the general goods we can observe and experience in the

public, such as fruits and drinks. They can easily recognize it by smelling and induce the same result. However, Harley et al. pointed out smell is modality, it varies from people, based on the age, gender, culture and lived experience (Harley et al., 2018). It implies that people might have different perception of smell towards the same goods or environment, then induce different recognitions. For example, the sourness of orange is different among countries, as the different ratio of limonin contents of the oranges contained. People have the perception of orange based on smelling the sourness of the oranges. Thus, people may unable to recognize scents are oranges if the scents are different from what they common perceived. As people have different perception of smell, it is difficult to collect data of the odor components (Nozaki and Nakamoto, 2016). To generate a scent that most people can recognize, research is needed to gather the information of the odor components, then figure out a formula which most people can recognize that scent. Therefore, data of odor components are essential to lead to same perception of smell towards the same goods.

# TOUCH ON VIRTUAL REALITY

## Current stage of developing touch on virtual reality

The sense of touch is essential in the human body. With the help of sight, we can see the object, but with the sense of touch, the human body gets to know about the properties of the object like texture, shape, temperature, hardness, and softness of the object (Saddik, et al., 2011). Touch is the sense that makes the world real for us. People may question the reality of view, sound or even smell because sometimes they can mislead us. But no one doubts the sense of touch. If we can touch it, it is probably real. So, if the touch is the best indicative of reality then we need this technology in virtual spaces and environments to make them real for people. So, touch in virtual reality is a concept that us to be able to touch and feel in Virtual Reality. This is still a new technology that we are yet to adobt. It is mostly in its developing state and it is getting better day by day.

Right now, the devices that are developed are generally using haptic engines to simulate the sense of touch. TeslaSuit Glove is a big example and step for this technology. “The "Teslasuit Glove," as it's called, combines several different technologies to detect hand and finger movements, and provide various types of feedback to simulate the sense of touch. Each fingertip, for example, is equipped with a 3x3 haptic display, enabling users to feel virtual textures naturally.” (Paul Lilly, December 27, 2019, This VR glove aims to bring the sense of touch to virtual objects). This glove has sensors that works together with force feedback and motion capture also it has resistance and vibration features. They even included a biometric system to track and understand the user’s heart rate, emotional state and stress level. This glove developed for medical rehabilitation reasons, but it can be used for any kind of industry, like gaming.

The other important device that is still is in developing state is wearable skin. This is more of a developed technology compared to Teslasuit glove because rather

than simulating feel of touch like haptic engines, which may not feel like real sensation of touch, this has pneumatic actuators that make you feel you are actually touching something. This artificial ultra-thin skin can adabt to your movements. Also, it has sensors that sends data to adjust the pressure. “The engineers’ prototype claim that they can offer touch feedback in real time at a 100Hz frequency and with a force of one newton, the force needed to accelerate one kilogram at one meter per second squared in one direction” (Jesus Diaz, October 01, 2019, New wearable skin lets you touch things in VR and be touched). This device is also created for medical reasons but we can apply to this any kind of industry that are using Virtual Reality.

## Benefits

The biggest benefit of this technology is to enhance the feeling of reality in virtual environments, but it also makes the experience way more interesting and fun. Engaging touch in human-computer interactions would enhance robotic control, physical rehabilitation, education, navigation, communication and even online shopping.( Matthew Hutson, 12.20.2018, Reaching out to touch virtual reality ) If we apply this technology to medicine and medical schools for doctors and students to study a surgery in a virtual space with the sense of touch, it will make their learning easier and safer. Also, we can apply this technology for military students to work and practice for dangerous situations that require sense of touch. This technology could be very beneficial for curing phobias and anxiety disorders. Actually, this method is being used with only virtual reality without sense of touch and it is pretty successful. And if we add the sense of touch then it will increase the success ratio. Another benefit is playing games will be way better and fun and it will make the experience better.

## How far are we from making it mainstream

Current Virtual Reality technology is still in its early stage of development. Right now, virtual reality mostly focused on the senses of sight and hearing which is not enough for full immersion at all. A problem with integrating the sense of touch is, while creating devices for touch, companies mostly think of implementing it to

hand, but for full immersion we need to be able to feel of touch in every part of our body. For that we have to create a suit or some kind of technology that will cover the whole body. But some of the potential users may not want to wear that. The suit will be probably heavy and it will be too expensive to buy or the production of a suit will probably cost a lot and it will be hard to produce.

“HaptX actuators can be used in this suit to simulate the sense of touch in the body and FeelReal mask to simulate the wind, water mist, and odor. Game developers can develop a game with more possible game mechanics for serious gamers who want an immersive gameplay experience. This still can be difficult to implement because of compatibility issues, but we can say that in the near future it is possible to simulate all the human sense in VR to make the experience more immersive. The field of VR is emerging, and people are doing more research and developments in this field to make VR experience more realistic and immersive.” ( Himanshu Limbasiya, 2018, Sense Simulation in Virtual Reality to Increase: Immersion, Presence, and Interactions). So, despite the problems or issues it is likely to integrate the sense of touch to virtual reality. But creating a perfect device like this and selling it to user’s still looks a little far away in the future.

## TASTE ON VIRTUAL REALITY

### Current stage of developing taste on virtual reality

Virtual Reality also called VR is a system which is 3-D environment which is computer simulated artificial environment which could transform physical world into imaginary world with the help of head-mounted displays.("Virtual Reality", 2017) The main goal is to make the user experience how total immersive is the VR. The main characteristics of VR are: Interactive, Immersive, multisensory, synthetic. While the technologies needed are Head-mounted display (which contains a display with specialized lenses and headset to track movements), controllers, keyboards, hand gestures and voice commands. Though it seems to be similar to game controllers, but VR is really helpful for entertainment industry as VR apps, medical industry and in construction industry to train employees as well as in software industries to introduce their software to the newcomers.

Taste is considered as the most prominent senses, which motivates animals to consume different varieties of food. This part of virtual reality simulation has undergone a lot of works, but few works could only add value to develop taste in VR. (Skarredghost, 2017). Hence, those works have been considered as more useful to study more about taste in VR.

At present, there are about 4 dominant works contributed to experience taste virtually. The most important and first accepted work world-wide was by Nimesh Ranasinghe. He has done lots of research in emulation of taste as well as in taste communications (Ranasinghe et al., 2011)."He developed a device that could produce fundamental tastes like sour, salty, bitter, sweet. He achieved this taste emulation by having a box containing both electrical and thermal controlling units, both of which have two little metallic foils at its end". In order to feel the tastes, the tongue is kept between the two electrodes. It was his first work and was called as digital taste actuating system. In his later works, he could develop three more tastes.

Nimesh Ranasinghe, later have developed a device known as "digital lollipop". (Ranasinghe and Do, 2016), in which he has replaced the lickable box by more comfortable digital taste lollipop, which in turn is wired to a box containing buttons through which one can decide which kind of taste to experience.

Later by 2018, a team of experts from from Imagineering Institute in Malaysia and the City, University of London produced digital taste by a thermal taste device called "Thermal taste machine", which can produce sweet, chemical, minty, fatty and pleasant sensations of taste. They could create not only five kinds of sensations but also recorded 20 types of thermally induced sensations and presented how they were modified by heating and cooling (Karunanayaka et al., 2018).

## Benefits

The benefits of this technology lie in its vast amount of applications. Taste emulation technology can have enormous amount of applications. It could be divided into two parts. One lies in entertainment ones and other medical ones.

In entertainment industry, there are a wide range of applications. Game industry is having the one of dominant areas of application to entertain game players by virtually making them more engaged in game. (Cao, Xie, & Chen, 2019). This is aimed to improve player's key needs and characteristics of game. It is considered according to three perspectives: the player needs, player mode and functional modulation of sensor in game. This resulted in improving VR game's performance. Also there was another study in which they studied of there could be any side effects in using these devices, which says wearable sensors are more reliable and can be effectively used.(Cui, Yeh, & Lee, 2019).In addition to this there was another study by (Kerruish, 2019) .In this, they incorporated smell and taste as the important dimensions in body perception in AR and VR. An example of this is seasonal traveller(VR game) in which player moves through different seasonal landscapes .Hence to provide a good experience they have added wind, odour, and temperature in addition to more standard video-audio displays.

Another benefit which could result is from the medical industry, in which diabetic patients could taste sweet food again. (The Ghost Howls, 2020)

Even though VR with these 5 senses incorporated in it make total immersion, there is another advantage which could result from these studies. That is the Taste over IP, which is a protocol in developing phase by (Ranasinghe and Do, 2016), in which one could send a tasty message as SMS to someone else. This could be achieved by an XML format which defines type of sensorial experience that device has to make feel to the receiver based on taste standards. If this could happen, then it will be another era of technology in our life.

## How far from making it to mainstream

In the current world of VR, though the main focus is on sense of sight and hear, there are numerous works done side by side so as to improve the VR senses. This is because there have studies, which have shown some negative and positive feedback of using sensors in daily life.

Most concern is about health of individuals, though the study (Cui, Yeh, & Lee, 2019) have revealed there are not much side effects for this technology. But the main areas of concern are the physical and mental health of people, which is already explained by the study of (Zanolli, 2019) in the above section related to smell.

Even though these works could result in making digital tastes, but a study by (Diefenbach, 2019) shown that the taste of food differs in different environments. As a result, in order to create the best experience of taste, the device could also have to introduce the sense of smell as well.

One of the best future work explained by (The Ghost Howls, 2020) is called " Project Nourished" involves a lot of different experiences of mixing VR and AR with food. It is actually in developing phase as of now, but more information about the product is being well explained. It is a device containing a VR headset, an aromatic diffuser to create a sense of smell, spoon with which one can experience real experience of eating food, 3-d printed food - which could be touched via hand controls.

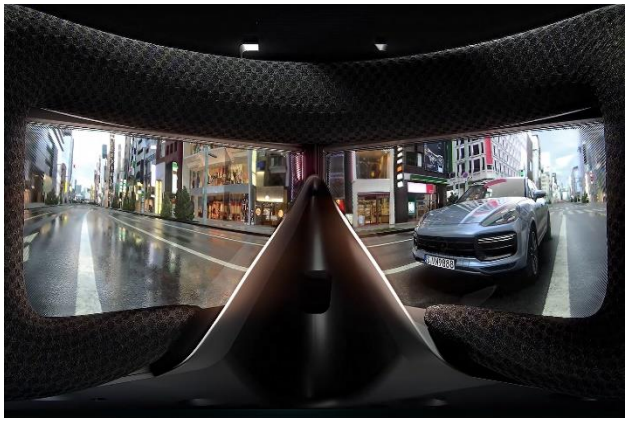
In general, if this last work becomes a successful one, there will be world of people experiencing real and virtual senses in similar ways. Though it could result in many a disadvantage, this work could be helpful for many people. The educated guess we could make at this point is "There might be VR wherein all the five human senses could be experienced in a near decade".

## DISCUSSIONS AND CONCLUSIONS

### Existing senses

Commonly we have two senses existing and developed enough, Sound and sight. Since sight and hearing are wave based, they are easy to transmit them to digital bits. “The screen displays two images adjacent to each other, one for left eye and one image for right eye. The combination of lenses is placed above screen, enabling the zoom in-out and re-shaping the picture for both the eye, thereby creating a stereoscopic 3D image. Rift devices monitor the wearer's head motions by the embedded sensor and accordingly adjust the image.” From this

sentence wrote by Ishan Goradia, Jheel Doshi and Lakshmi Kurup on a review paper about Oculus rift, we can understand that sight is very developed and realistic. Also, since the invention of television and radio, sound is easy to adjust to the machines too.



5.2 Addition of other senses to VR

The research work done above prevails that the addition of other three senses to VR could make a larger impact in today's world of VR. By enhancing “the sense of presence”, VR could really add another definition to the smart applications that exist today.

It is clear from the studies done above that, though the existence of many senses could add value to the sense of smell, taste and touch, but there are still many researchers working behind this, which is a great news for the next era of technology. Although many devices like smart phones and watches have already been reached to its high potential, VR still is lacking many features.

Results

Results based on our study shows that, the three senses that are not that available on virtual reality is being included and developed with time. Due to this developments, researches and studies, we will be able to create a VR headset that includes all these five senses and make them compatible. But it is still in the future that they will be mainstream and efficient to use and sell.

Conclusion

The next era of VR is clearly defined by the project called “Project Nourished”. It is the enhancement of VR to total immersion. It is achieved with the help of results

from other similar researches done in that field. Also, many researches have shown that it's possible to incorporate all senses in VR.

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# XR AND IOT IN PROFESSIONAL APPLICATIONS -TRANSFORMING WAYS OF WORKING

Group Assignment
Emerging Technology Adoption and Use
TLO-35307 2020

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# ABSTRACT

Ekwere, K., Koponen, A., Lehtonen, M. & Tuominen A.:
XR and IoT in professional applications -transforming ways of working
Technology: XR with IoT
Context: Professional applications and working life
Lens: Technology adoption

Day by day our lives continue to be changed by the advent of emerging technologies, it is a fact that we are in the period of change, and speedily it will it come, and will it remain. Our objective is to look at what happens when two of these emerging technologies merge. Although just in its nascent stages, but it is beginning to happen. We see the how virtual technology and augmented technology are merging to create new products and solutions for users. We also are beginning to see how augmented technology, virtual technology as well as internet of things are being used to answer some of modern mankind's problems. These will continue to happen and we humankind will continue to be experience the benefits that these will bring about.

In reading this, we hope that the reader will be have an insight to what the future may look like when these technologies merge. We, here and now in 2020 do now know what 2030 might look like, but we are beginning to see amazing things being done and brought to light, with the combination of these three emerging technologies. In this report we will give a few examples about that. We will also hope that the reader, will be able to explore and bring forth other ideas and suggestions as well as applications in which the emergence of these technologies could bring forth more solutions. In a way we hope this triggers a discussion, an ignition to see the advantages of this concept as well as the benefits. We believe that an open and honest conversation about these will be of immense benefit.

The reach and span of emerging technologies continues to reach deeper and further in our lives. We the writers foresee a period where we will no longer be talking about emerging technologies on a singular basis, but as an ecosystem, combined and adapted to perform a task and to serve a need. Technology will become more and more intimate as well as more and more personal, this is the right time to investigate the future and see what it might behold us.

We have spoken to users, and brighter minds on this issue, interviews have been carried out as well as on sight visits to industries that are also exploring these idea and hoping to answer the questions of the future, we hope that our findings and research will enlighten the readers and give a perspective on the direction of the technologies and their possible use, especially when merged.

Keywords: XR, IoT, Technology adoption

## INTRODUCTION

In today´s business and working environment emerging technologies are constantly playing a bigger role. Technology is an essential part of enhancing the organizations' competitiveness and it has significant effect on the productivity of organizations operations. With mobile working increasing in many industries, employees can nowadays have the possibility of working anywhere while still being able to virtually access the office or other remote locations. Modelling information and operations virtually or overlaying them on top of physical reality allows employees to access and evaluate information easier and faster and hence make faster decisions than ever before (Thomas 2019b).

Emerging technologies offer a wide range of interesting applications and number of opportunities that are coming into our lives at a rate that has never been seen before. As individual technologies are still emerging, already innovative combinations are developed at the same time. In this study we offer an overview on one of those exciting combinations and how it could enhance performance and transform ways of working much easier compared to traditional practices. However, despite of the exiting possibilities, we need to consider that many of the emerging technologies haven't quite yet mainstreamed in professional environments. As new technologies are developing rapidly it is important to take time to understand the determinants, that affect technology adoption. After all, technology is only useful when it is actually used.

For this research we use the Emerging Technology (ETAU) -framework as the fundament of our approach to study emerging technologies. The framework includes choosing the emerging technology or technologies, context and the research lens. The chosen emerging technologies combine extended reality (XR) and Internet of Things (IoT). We chose this combination since its' novelty level is greater than XR or IoT alone and it hasn't yet been as widely adopted as the individual technologies. The context for our use case-review, case interview and theory reflection are professional applications and working environment. Our goal is to understand and theorize how XR enhanced with IoT changes business, professional life and ways of working now, or could change in the future. To enrich and validate our research we conducted an interview with a company that designs virtual twins of buildings, mainly factories. Hybrid research lens combines two

technology frameworks. In this paper the XR with IoT -technology implementation in professional surroundings is reflected on individual perspective through Technology Acceptance Model (TAM). On organizational reflection we use Technology-Organization-Environment Framework (TOE). With the help of these frameworks we hope to understand the supporting and hindering factors that impact the adoption of the innovative combination of XR and IoT in professional organizations.

## Research methods

This research is conducted by literature research and with one interview. The literature research is focused on different technology adoption models specializing in the technology adoption model (TAM), Technology-Organization-Environment (TOE) model and in different real-life examples of IoT in extended reality. The research materials utilized for literature review are retrieved from Andor database and supplemented with contemporary internet articles. Free internet search is utilized especially in the use case examples since the concept of combining these emerging technologies is relatively new and thus comprehensive scientific peer-reviewed articles are quite rare.

The interview was conducted by 2-hour theme interview. The interview themes were designed together with the group and the interview was conducted by two team members. The interview themes consisted of VR, possible use cases for IoT in mixed reality in the company's operations and value creation. In the end of the interview a set of semi-structured questions relating to the TAM and TOE model were asked from the interviewee. After the interview the answers and notes were examined, and color coded to highlight the repetitive themes. The answers of theme interview part were also reflected to the TAM and TOE model in order to identify if there are resemblance to the theory.

## Interview findings

In order to enrich our understanding on the subject, we interviewed a representative of a company that designs virtual twins of buildings, mainly factories. The organization is a company, whose core business is to plan and design communi-

ties and cities of the future by offering services in the fields of consulting engineering, environmental technology and architecture. Our main findings were that VR already offers several useful solutions for engineering and architecture. VR environments are especially useful in transmitting information. Designs, such as factory layouts and pipeline routes can be viewed and discussed explicitly. VR allows its users to convert tacit knowledge into a more explicit form.

The main limiting factors for technology adaptation are both technological and demographical. Improvements in VR glass technology, and processing power in general, would further boost their potential. Drones are also be being to great effect in 3D imaging of buildings. The greatest limitation to drone usage isn't necessarily drone technology itself, rather the lack of powerful AI solutions to process the imagery. Demographic factors, such as the age of employees are also considerable factors in terms of technology adoption – younger people are eager to embrace the new technologies, while older people are reluctant to do so. This, of course, is common in many technologies, but it's especially emphasized in XR solutions.

## Structure of the paper

This paper is structured as follow: first it defines the differences of virtual, mixed and augmented realities and the concept of IoT, how IoT is able to enrich the extended reality.

After defining the concepts and their relations, in chapter 3 the paper focuses on the TAM and TOE model and how the different frameworks explain the adoption of new technology both on organization and on the individual level.

In chapter 4 an overview of "XR with IoT"-use cases is provided as well as general review on how these technologies have changed or are expected to change working environment.

Finally, after presenting our case interview results, we analyze the outcomes with the help of the TAM and TOE frameworks. We identify the factors and enablers of the new technology adoption and how they become apparent in the case.

## EXTENDED REALITY AND IOT

With emerging technologies, which haven't quite mainstreamed yet, there are quite often confusion with concepts related to them. Rather than a one specific technology, extended reality (XR) is more like an umbrella term for several immersive technologies. So far it refers to augmented reality (AR), virtual reality (VR) and mixed reality (MR) technologies, but perhaps in the future to others as well. (Marr 2019b)

In figure 1 the different technologies' relationships to reality are illustrated:

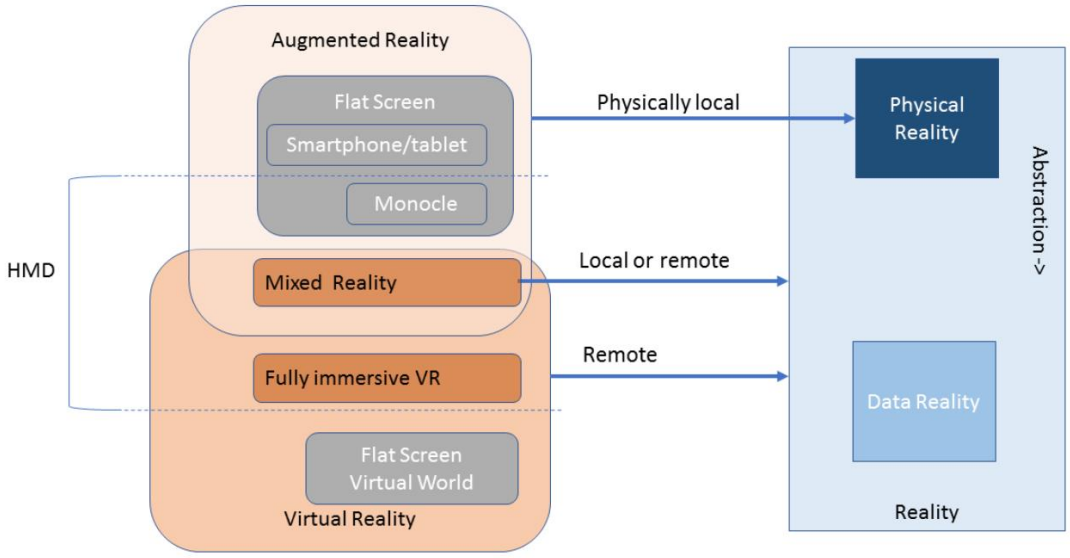



*Figure 17 Systems architecture view of reality (Thomas 2019a).*

On the right side of the figure **two different realities** are presented. For example, an actual machine is physical reality. But reality can be abstract as well. Abstract data reality could for example be the supply chain for the machine or IoT (Internet of things)-driven information overlay of the machine operations. (Thomas 2019a) In that sense IoT is one form of abstract reality brought to extended reality environment.

In **augmented reality** the digital details like virtual objects or information are overlaid on the real world. AR is always local to the proximate physical reality, where users see the real environment as well and can interact with it. The experience can be accessed with AR glasses, smart lenses, displays and with mobile devices. (Thomas 2019a; Marr 2019a)

In **virtual reality** environment the users are in fully digital environment where the surroundings are completely simulated. The user is always remote and detached from physical reality. VR-headsets (commonly connected to PC or console) need to be used in order to get a 360-degree visibility or the artificial world, which completely blocks out the physical reality. (Thomas 2019a; Marr 2019a; Marr 2019b)

A **mixed-reality** environment goes a step beyond augmented reality because users can interact in real-time with virtual objects that are placed within the real world. It can be local, like AR, for example a digital overlay on a proximate machine. It can be remote and immersive as well like VR, for example 3D model of a factory examined and modified by interacting with digital objects in a fully virtual setting. Gesture, gaze or voice recognition technologies enable virtual items to respond and react to users as if they were actual objects. The holographic experience requires MR-headset. (Thomas 2019a; Marr 2019b)

**Internet of Things** can be characterized as network of devices that incorporate sensors to collect, transmit and automatically exchange information about the devices themselves, or other devices and machines, as well as about environmental conditions and human related information (Mann 2017).

## Extended reality with IoT

Modern XR technology can act as medium for digital IoT stream. The physical or virtual reality is fed by IoT data which can be in real time or a presentation from past events retrieved from data storages. (Thomas 2019b) As an example of combining the XR with IoT, a technician with an AR-device, looking at a machine could see an IoT-driven overlay of the machine operations or service history and predictions. Instead of having to take the machine apart, IoT-driven MR-rendering projected on the outside of the casing enables the worker to see the components and interact with them. With VR, he could also see the same operational information from a machine in another location. Then, he could interact with both artificial and human remote experts about action plan, which could include the expert feeding virtual overlays into the technician's view. (Thomas 2019a)

Figure 2 illustrates IoT and XR utilization in smart city context, but the same analogue can easily be expanded to other use cases:

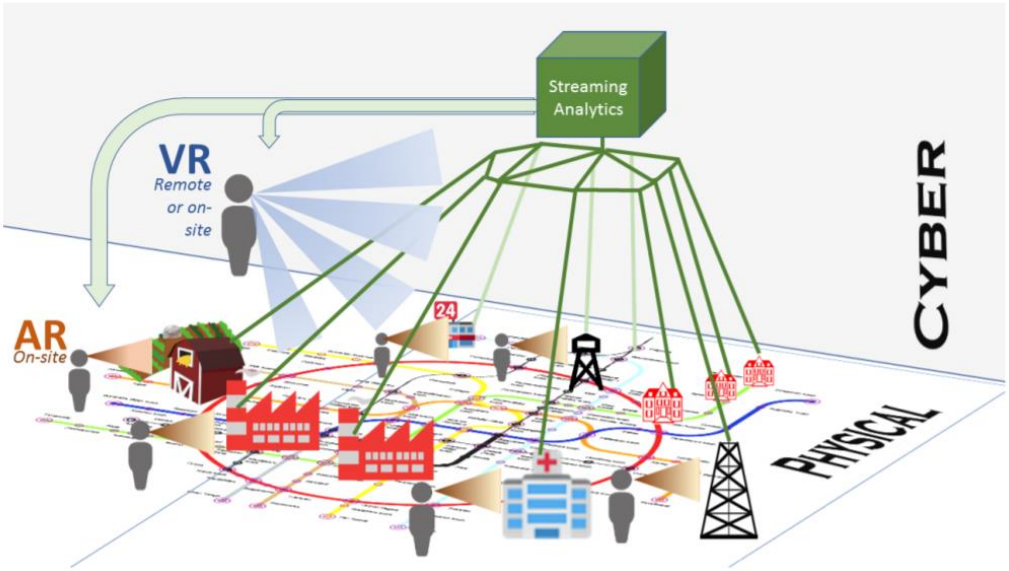



*Figure 18 XR technology as medium for IoT-data stream (Thomas 2019b)*

With the streaming analytics of instrumented physical locations (e.g. factories and/or machines) and IoT-networks, AR technology provides on-site possibility to explore and understand the conditions and infrastructure of the target object, construction or environment. VR on the other hand, enables more holistic analysis remotely from different sites and events without physical world restrictions. (Thomas 2019b)

## FRAMEWORK INTRODUCTION

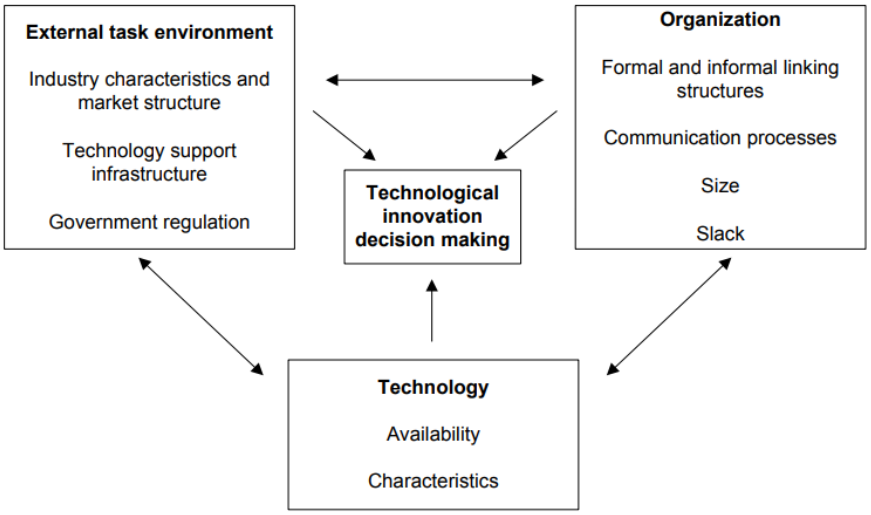
These days, the information technology is an essential part of enhancing the competitiveness of the organizations operations and it has significant effects on the productivity of organizations. As IT and new technologies are developing rapidly it is important to understand the determinants of technology adoption. The research literature identifies multiple information technology adoption models, and in this paper, we will discuss about the models focusing on the adoption on the organization and on individual level.

Some of the most used theories are the technology acceptance model (TAM) and the technology-organization-environment (TOE) framework. The TOE framework was developed in 1990 by Tornatzky and Fleischer and it identifies three different

aspects influencing the adoption and implementation of technological innovations at the organization level. These three aspects are *external task environment, organizational context* and the t*echnological context* which describes both internal and external technologies relevant to the firm focusing either on the availability or the characteristics of the technology. (Oliveira et al. 2011) Technological context refers also to the performance expectancy which technological innovation is superior to the current ones in use and to technology maturity. Technology maturity describes the organizations technological architecture and its readiness to deploy new technology. (Schmitt et al. 2019)

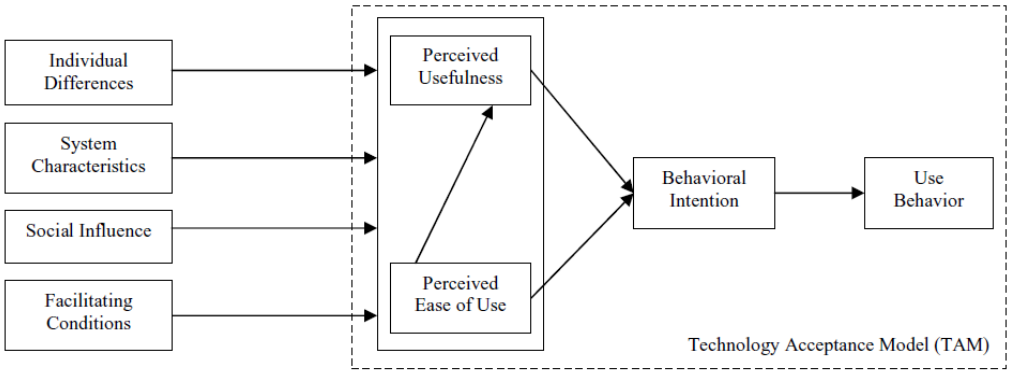
Organizational context refers to organization's internal characteristics such as the organizations size, attitude towards change, organizational slack, perceived technical capability, and security concerns. According to studies the larger companies are usually more prone to absorb more risk and greater flexibility which are important in adopting new technologies. In addition, large companies have usually bigger budgets to experiment. The attitude towards change is essential for organizations' willingness and ability to implement new technology and to transform the organization. (Schmitt et al. 2019)

The environmental context is the arena where the organization conducts its business. It describes the industry characteristics and market structure, technology support infrastructure such as network connections and government regulations. (Oliveira et al. 2011) Furthermore, it describes the competitive pressure, consumer perceptions and external data. In this context the external data refers to indicators that triggers the execution of new technology outside the organization. (Schmitt et al. 2019) TOE framework is presented in picture 1.




***Picture 2 TOE framework (Oliveira et al. 2011)***

As the TOE framework focuses the technology adoption at the organization level, the TAM model describes the adoption on the individual level. TAM model was developed by Davis, Bagozzi and Warshaw in 1989 and it identifies the determinants which effects the user's acceptation and use of new technology. In the model the actual system use is an endpoint for combination of different factors such as individual differences, system characteristic, social influence and facilitating conditions that all affects to the users perceived usefulness and perceived ease of use. The perceived ease of use is also affecting to the perceived usefulness. The combination of these two factors forms the basis for behavioral intention to use the new technology that leads to the actual use behavior. (Venkatesh et al. 2008; Marangunic´ et al. 2015) TAM model is illustrated in picture 2.




***Picture 3 TAM model (Venkatesh et al. 2008)***

TAM has been developed over the years as the research have identified new relationships influencing the perceived ease of use, perceived usefulness and the behavioral intention. (Venkatesh et al. 2008) As understanding the adoption process it is easier to influence and lead the adoption and use of technological innovations and to implement them as part of normal everyday work life. After getting to know the technologies and their adoption in theory we will focus on considering their possibilities in real life next in chapter 4.

## VR & IOT – PRACTICAL APPLICATIONS

XR technologies, when combined with IoT, offer a wide range of interesting applications that could be utilized in the near future. Real-world buildings, such as large factories can be modelled in a VR environment, which allows users to “access” the factory grounds remotely. These digital twins of factories are currently being developed around the world. The VR model is particularly useful in transmitting knowledge. Designs and plans can be explicitly stated in the virtual environment at a very low cost. Making real-time changes to designs is also possible in the virtual environment, which allows designers and end-users to discuss their options visually. VR technologies like digital twins help to transform information into a more explicit form.

Virtual models also help to visualize things that would otherwise go easily unnoticed. Because the model simulates a real working environment, workers can use it to perform their ordinary work tasks before construction on the physical factory has even begun. If the worker notices something impractical about the design or layout of the factory in the virtual environment, it's easy to change the design at this stage. Virtual models not only make designs more unambiguous but also allow its users to transmit information about objects that traditional models would fail to notice in the first place. The model's ability to allow these features scales

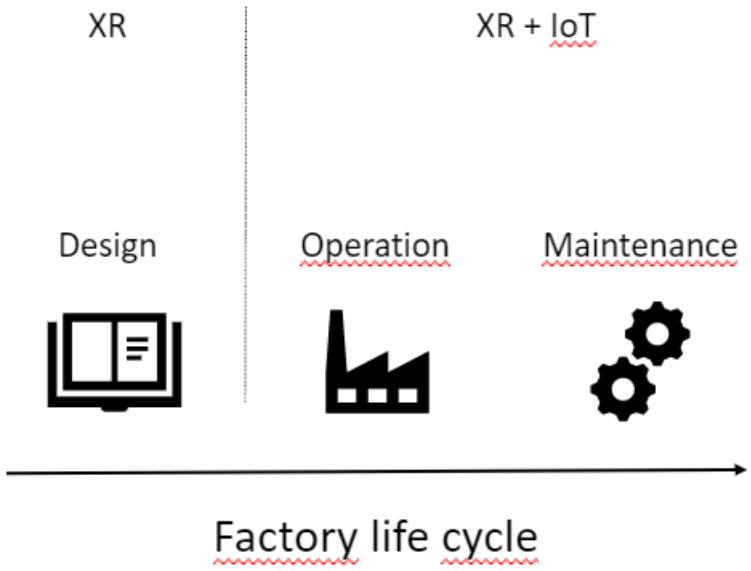



***Figure 19: VR and IoT in a Factory's life cycle***

directly with the quality of the model. The more immersive the virtual environment, the better it is at facilitating knowledge transfer.

The current technological applications mostly revolve around VR. While the VR applications can definitely use a lot of improvement still, incorporating IoT would allow for completely new applications. As seen in figure 3, the design phase in a factory's life cycle will mostly rely on VR in the future as well as there are very few sensors to gather IoT data with. However, in the actual operation, IoT offers a number of potential opportunities when paired with VR.

If a physical factory can be connected to its virtual counterpart by IoT sensors, the running factory can be fully transferred into the virtual world. This means that the digital twin of the factory would no longer be a lifeless dummy, rather an interactive simulation of the factory's everyday operation. Factories enhanced with

VR and IoT, could then be monitored, and even interacted with, remotely. Solutions like this are especially useful in processes that handle dangerous chemicals or those that are in a hard-to-reach locations, such as mine shafts. A well-executed combination of VR and IoT would also help to improve traceability in the process, making it easier to notice errors.

## Virtual and Augmented realities IoT - workplace implications

Virtual and augmented reality is increasingly becoming a tool that is used in many workplaces as well as many work environments. As an emerging technology, its use as well as capabilities are still in its naivety, but we can already be able to discuss and elaborate on its use as well as functions from an employee´s work perspective.

The combination of Virtual and augmented realities with the internet of things, expands the horizon and possibilities of the workplace as well as the work environment. It becomes ever more possible to answer harder questions and conduct more advance simulations as well as researches. Users of these products as discussed below have the possibility of experiencing the realities of products and environments before purchasing or using it as a simulator or educational enterprise. In a way with VR/AR, and the internet of things, as being investigated by the Tokyo Virtual Living Lab; the test driving of a new car might be experienced even without the availability of the car itself. Another example of this, is the change in driving schools, were with VR/AR the option of night driving classes can nowadays be practiced at any time. Combine this with the internet of things, might possibly result in even more options for the driving school student. These are experiences that they clients and consumers can experience, just to mention a few, these changes are also being felt by the workers, sellers, marketers, designers etc.

A Personal example, that would be worth mentioning, is that of an auction event for apartment blocks in central London. For the housing agents tasked with selling these apartments, they had the option of accepting offers from Asia, because they had set up an AR/VR viewing terminal, and for potential buyers in Asia to view the flats. It is possible to envisage that in the future, if the internet of things

was combined to this case, benefits such as data, as well as assimilation of processes might be achieved. This is an example of the widening of markets as well as widening the experiences,

## Cases with the employee´s work perspective

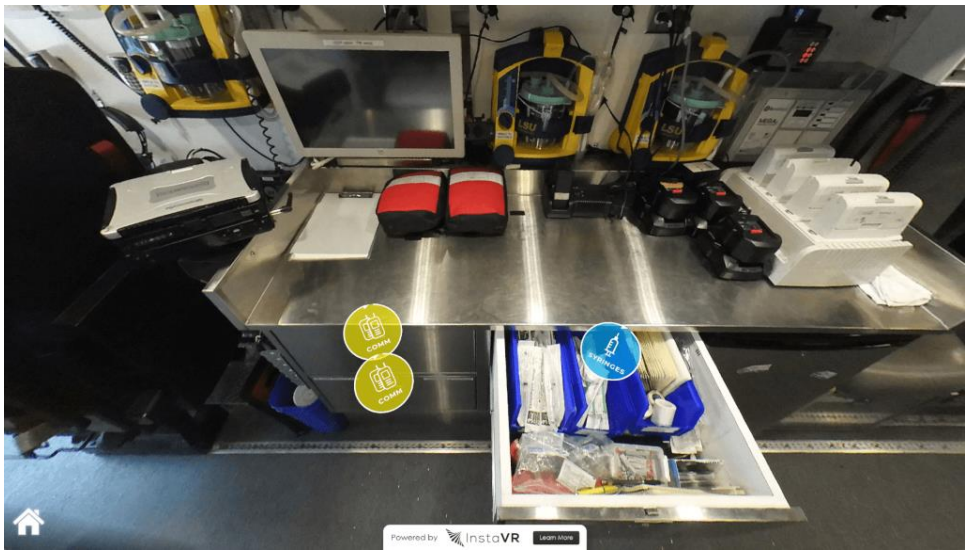
In an ever-expanding market, the ever-expanding perspective, brings many changes to the customers as well as the employees. From an employee perspective, emerging technologies brings many advantages as well as many opportunities. For instance, from the employee´s perspective; Virtual reality and Augmented reality are catalyzers in improving work collaboration, with the internet of things playing a role it would allow the employers to acquire a much more knowledge and data. The combination of both technologies allows for the rapid enhancement of marketing materials. This allows for ideas to be shared as well as illustrations to be made and editing to be more interactive. From the employee´s point of view, marketing materials that would expands the interacting scope as well as communicate via all the immersion senses, is a powerful tool in the constant expanding arsenal of employee tools. (Lawrence 2018)

Moreover, there is a constant shift from the hypothetical to real world training. This is happening on an ever-greater scale all the time. One notable user of virtual and augmented realities combinations is NASA. NASA employees have been able to experience more and more what they, in the past would have possibly only experienced in calculations and imaginations. With NASA being a firm believer in embracing emerging technologies, it has now been able to conduct simulations, in ways that would immerse its employees be it would be astronauts, or rocket technicians or NASA Space employees in the environments that in the recent past would not have been possible. As this technology becomes more embedded in workplace environments, we will continue to experience the benefits of virtual and augmented realities. (Lawrence 2018) In short there is potential to combine these technologies with the internet of things and to create ever more advance products and solutions.

In today´s workplaces, flexibility and mobility are a very essential part of the modern workplace. With emerging technologies constantly playing a bigger role in

workplaces, they are being used to increase these properties. With mobile working gaining in many industries, employees can nowadays have the possibility of working anywhere while still being able to virtually access the office. Therefore, it can be said that virtual and augmented realities offer employees more autonomy in terms where they can work as well as how they choose to work. This in turn can have a positive impact on employee morale and a better work life balance.

As in a real-world experience, in many workplaces, it is expected and required that emergency drills are practiced. From the employee's perspective. Using virtual and augmented realities is a phenomenon, that has been proven to help in preparing for these events as well as being able to learn about the possible environments and situations that might occur during an event as such. From the employees' point of view, this brings an awareness and confidence, that is very important in situations of emergencies.




Vr, Insta. “Example Use Cases of How to Use Virtual Reality (VR) for Training.” *InstaVR*, 3 July 2019, www.instavr.co/articles/general/example-use-cases-of-how-to-use-virtual-reality-vr-for-training.

Virtual reality lab Texas has been actively researching the idea of using virtual reality with augmented reality as well, to create a platform that can be used to train and simulate emergency situations. The platform that has been created, is an emergency vehicle, that can be used in the simulations of emergencies. This has been achieved by marrying both emerging technologies. The internet of things also plays a part in making this educational and training platform mobile and remote.

The internet of things which itself is an emerging concept, gives virtual realties and augmented realities the platform as well as the architecture for these technologies to expand and be used. The internet of things allows for data to be collected in augmented and virtual realities. It also allows for the embedding of many more programs and options into the virtual environments. The marrying of these technologies allows for the more efficient of gathering of data, and thus for the more expanded use of augmented as well as virtual realities. (Vaccari, A)

This is a concept that is being explode actively in creating the smart cities of the future. A similar project is being developed in Japan, by the Toyko virtual living lab, which is marrying these technologies together in other to create a simulation of the traffic situation in Japan, with the overall goal to simulate a driver and its effects using a virtual user controlled vehicle in a 3D environment. These kinds of technologies and concepts will become increasingly present in our everyday lives, as these emerging technologies continue to merge and evolve independently as well as collectively. (Vaccari,A)

## Interview implications

Although the company we interviewed does not currently include IoT in their applications, we identified several potential areas, which could be improved by incorporating IoT. IoT could be used to obtain real-time data from the factory that can then be fed into the digital twin. This would greatly improve its usability outside of just designing buildings. The 3D-imaging drones could also benefit from IoT if they were able to process sensor data in real time while flying. This would probably require some advances in the field of AI as well, however.

Another real-life use case through our professional network that we unfortunately were unable to interview properly in the given time-limit is a Finnish robotic company that is planning to use VR in their showroom to demonstrate and control the robots working in challenging conditions such as mines. In this example they are currently developing an IoT solution implemented in the VR which could help the user to adjust and manipulate the environment in specific parts of the mine and to see the effects in real time. With the help of IoT implemented in VR the user is able to perform their work without the need to be present in the depth of hundreds or thousands of meters. This solutions combined to the robotics can be used not only in mining industry but in several different contexts such as in primary production where the user could see the real time situation in VR and adjust the

environmental conditions like lights, temperature or moisture according to the observations they make produced by IoT.

Even though this combination of IoT and VR creates many opportunities to revolutionize the industrial and primary production there are identified challenges that need to be tackled. One of the identified challenges is the expenses of reliable technology with enough computing power and the network quality of the current infrastructure. In addition to these technological challenges the project group has identified security to be an important aspect as the solution would be embedded in more critical environments. Furthermore, the primary production is a field where the way of working is still in some areas very manual and the attitudes towards disruptive technologies varies a lot.

## Reflecting to frameworks

The interview, examples gathered online, and our own reasoning can be reflected to the frameworks. First of all, the interview we had from the representative from the construction field suggested that the adoption of new technology is a combination of internal and external forces where individuals and their perceived usefulness may have huge influence on the outcome. The individuals perceived usefulness and perceived ease of use may not be enough for the organization to adopt the new technology since there are always external forces to consider on the organization level. For example, is the company willing to invest in new technology, does their external environment support the use of new technology or are their customers yet ready to change their way of conducting the business in a way that new technological innovations could add value.

In more detailed level the perceived usefulness in the interview was identified especially to be related to the collaboration of individuals in real time. In construction business it might be hard to understand the outline of the design or effects of small changes before the actual building is complete but in VR the designers and stakeholders are able to see and experiment the changes cost efficiently, share and communicate their visions in order to achieve the best solution. In addition, the perceived ease of use was mostly positive among their customers, but the older people were identified to be more change resistant towards the new technology than the digital natives.

Other identified internal forces towards adopting new emerging technology were related to organization itself. The interviewee provided valuable information that the larger clients and stakeholders were more eager to explore and test new technology as part of their design process and the experiences were almost every time purely positive and they wanted to include virtual design as part of their projects in the future. In the mining example the project group identified the organizations attitudes towards the change to be the biggest issue why the solutions combining IoT in VR + robotics is very difficult to promote in the primary production industry. In addition, the potential clients have some security concerns related to IoT which needs to be considered and requires special knowledge in network security.

The external forces influencing new technology adoption that we identified in the interview were both technological and environmental factors. Technological factors were identified to be performance expectancy in network infrastructure which is especially critical in reparations. In reparations constructs the VR is quite easy to model and the network capacity does rarely influence on it but the plans how to implement IoT in it to gather real time data and make virtual simulations were considered to be yet quite challenging. Also, the technology maturity and reliability to have successfully implemented IoT in VR we seen as a challenge in some use cases.  VR were seen easy to deploy and the perceived compatibility was not considered to be a problem.

One of the external factors identified in the interview was the rising competitive pressure in the construction industry. As the competition of the customers is tough many are experimenting different ways to improve their competitiveness with emerging technology, and VR was considered to be one of the most popular tools to do that. As from the consumers point of view the VR solutions in design process were not seen yet as a standards but the interviewee had a hunch it could develop to be a part of the standards design tool set in the future due to its huge potential in decreasing mistakes and bad design.

To gather and wrap up our findings we have gathered them in picture 3 to visualize the identified factors divided in internal and external forces influencing the new technology adoption.


***Picture 4 New technology implementation and adoption***

## Future scenarios

In order to look at what the future would look like when these emerging technologies are combined, we think it is best to look at an organization using these combinations to ask as well as answer the questions of the future. The Tokyo Virtual Living Lab is an important aspect of the research and development of the Smart City project. It is designing smart cities with the combination of the three emerging technologies being discussed in this report: Virtual reality, augmented reality and internet of things. It is a combination of the three, results in a project that is combining the use of Virtual reality, Augmented reality and as well as Internet of Things to (a) To develop a pipeline that takes free map data as input and outputs a semantically graphical structure, the Navigation Network. (b) Building a Navigation Segment Agent that coordinates a Multiagent traffic simulator based on the Navigation Network; this supports the integration of user-controlled vehicles.

This project is implemented to experiment with human drivers in conditions of ubiquitous eco-traffic as well as normal traffic. This is a very vital concept as the

world continues to experience rapid urbanization as well as difficulties and opportunities that it might bring. In real-life scenarios, the Tokyo Smart City aims to investigate the impact of smart measures on human driving behavior as well as traffic flow. The result of this project is to create innovative control systems for traffics, and to be able to use the technology to create reliable traffic simulators. In a way this process is the beginnings of the creation of simulation of entities – in this case drivers in a virtual city, and thus try to understand the urban mobility of the future

The combination of the augmented reality as well virtual reality and using the internet of things as a connecting tool, makes it possible to create much more complex simulating experiences. In the future, we might begin to see these kinds of combinations in sectors of assisted living as well as healthcare, education and training, just to mention a few.

What we can show here is that now, Tokyo Virtual Living Lab is using these systems to answer complicated questions as well as to conduct deeper research in understanding the complicated questions that we will need to answer. We believe that in time to come, we will continue to see these kinds of combinations to answer ever more complicated questions as well as to provide products that will serve to our more advanced needs.

## CONCLUSIONS

In this paper we have explored the current situation and future possibilities of the combination of XR and IoT with the help of theory frameworks of new technology acceptance models. Based on our research the technologies are adopted widely in different industries separately but there is interest to combine these two to gain more value and to either have better remote control of different environments or increase the understanding of the current choices for future outcomes. The biggest challenges in adopting seems to be the internal forces such as people's attitudes and change resistant even though the experiences have been extremely positive. According to our research, the change resistant is more common among older people than among digital natives. In addition, as described in the TOE

model our research endorsed the finding that the larger companies are more willing to experiment due to larger budgets.

The adoption of new technology was reflected from the interview and from one team members' work towards the frameworks and both frameworks were identified to explain well the technology adoption. Even though the industries in different examples gathered from the interview or from the Internet were very different, the challenges seemed to be quite similar. The research could have benefit from multiple interviews but even with only one we managed to gain valuable understanding of real-life use case. For future research it would bring more value to follow how the combination of IoT in VR has developed in the target organization and what kind of challenges they have had. In addition, it would be interesting to see how the highly positive experiences influence on the change resistance lurking among the stakeholders.

The aim of this research was to gain better understanding of the supporting and hindering factors that impact the adoption of the innovative combination of XR and IoT in professional organizations. As identified from the interview and from the mining industry example, the use cases of IoT implemented in VR or AR are versatile and the forces influencing the adoption can be divided into internal and external ones. Regarding the industry the factors are quite the same and can be found from currently existing theories.

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